FISCAL YEAR 1988 DEPARTMENT OF ENERGY AUTHORIZATION

(Posture Hearing; National Laboratories)

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

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*Ranking Republican Member.
**Resigned February 19, 1987 (H. Res. 89).
***Elected March 30, 1987 (H. Res. 133).

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1988 DEPARTMENT OF ENERGY AUTHORIZATION

TUESDAY, MARCH 17, 1987

House of Representatives,
Committee on Science, Space, and Technology,
Washington, DC.

The committee met, pursuant to notice, at 9:35 a.m., in room 2318, Rayburn House Office Building, Hon. Robert A. Roe (chairman of the committee) presiding.

Staff present: Dr. John V. Dugan, Jr., Dr. Harlan L. Watson.

The Chairman. The committee will come to order. I want to welcome everybody on St. Patrick's Day.

The committee this morning will explore the policy implications of the DOE's budget request for 1988. In some cases, the budget recommendations de facto present an energy policy issue. In other cases, the level of funding for the program is not so much the issue as the program direction.

I think it is important, Mr. Secretary, that we outline our major concerns at the outset, so that we can engage in a constructive give-and-take during the morning's hearing.

In Nuclear Fission R&D, we have some concern with the overall funding level request for the program, as well as the allocation of dollars within the program, particularly with regard to the advanced reactor concepts.

In magnetic fusion, we are pleased to note that the Department is going forward with an ignition project, yet we are distressed to learn that the budget request for the Compact Ignition Tokamak project is, in fact, too low to maintain cost and schedule, in our judgment.

In the Nuclear Waste Program, we are not so much presented with a budget funding issue, but rather we have major policy concerns. It appears the program is in an embattled condition, and the committee must seek to understand whether legislation remedies are appropriate.

In the Uranium Enrichment Program, we are frankly puzzled by the Department's conclusion that the Government should no longer fund the Advanced Vapor Laser Isotope Separation Program, known as the AVLIS program. Yet back in 1985, we were told that AVLIS was the advanced enrichment technology of choice, and that it should be deployed by the year 2000. I don't believe that our foreign competitors around the world will be convinced of any serious U.S. commitment to low-cost service if we don't fund the AVLIS development.

In the general sciences area, we are highly interested in the prospects of the Superconducting Super Collider in terms of U.S. preeminence in high energy physics, but we are very concerned about funding prospects and the potential impact on other science activities.

In fact, across the spectrum of the Office of Energy Research Programs, we see critical needs for new facilities in magnetic fusion, basic energy sciences, nuclear physics as well as high energy physics. However, neither the five-year budget projection nor the Administration nor the individual program requests for 1988 are consistent with the recognition of these critical needs.

In Fossil Energy R&D and Clean Coal Technologies, we are interested in working with the Department to see that these critical technologies are demonstrated and become deployed as more desirable alternatives to wet scrubbers for acid rain mitigation.

We are also concerned that techniques for turning our abundant coal resources to oil and gas and enhanced recovery techniques for these important fossil fuels be encouraged. It is disconcerting that the Fossil Energy R&D and Conservation and Renewables R&D budgets are cut virtually in half form 1987 levels, and we intend to explore priorities in these areas with you.

Finally, the committee is committed to seeing that the national labs and other unique expertise will be used in an optimum manner to ensure U.S. competitiveness. In this context, our recommended committee initiative in x-ray lithography, which would involve unique capabilities at the laboratories is important to mention, and this effort would involve Brookhaven National Laboratory, Oak Ridge National Laboratory, in concert with several universities and industry, and Federal cost-sharing would be provided by both DOE and DOD.

This mission-oriented activity is nothing less than direct competition with the Japanese for who can reach—really to see who can reach the marketplace first with multi-megabyte chips in the early to mid 1990s. If competitiveness is to be more than just a buzzword within the Congress and the Executive Branch, this type of initiative must go forward with a tight timetable for accomplishment.

I would now defer to the distinguished gentleman, the ranking minority leader from the great State of New Mexico.

And where is your green tie this morning?

Mr. LUJAN. Thank you, Mr. Chairman.

Well, I forgot it this morning.

The CHAIRMAN. That's okay. [Laughter.]

Mr. LUJAN. I'm going to change my name to O'Lujan or something like that for now.

I want to join you in extending a welcome to our friend, Secretary Herrington. I look forward to his discussion of the Department's Fiscal '88 energy budget.

Mr. Secretary, I want to congratulate in helping the President meet his pledge to submit a Fiscal Year '88 budget that meets the Gramm-Rudman-Hollings requirements.

I am also pleased that DOE is continuing its strong support of basic research. Our nation's ability to meet global competition, to provide for the national security, and to improve the quality of life for all its citizens depends, in part, on national investments in science and technology. DOE's initiatives in these areas complement the other strong efforts being made by the Administration at other agencies, such as the National Science Foundation and NASA.

As you know, Mr. Secretary, of particular interest to this committee is the President's proposal to proceed with the construction of the next generation of high energy physics research facility, the Superconducting Super Collider. It's a proposal which, as you know, Mr. Secretary, I support. While we will be having an extensive set of hearings on the SSC in April, I'm sure that any additional information which you might be able to provide us at this time regarding site selection criteria, process, and schedule would be greatly appreciated.

So, Mr. Chairman, in closing I want to say that while I may necessarily have some minor—and I stress the word "minor"—disagreements concerning some of the Department's funding priorities, I want to say to you, Mr. Secretary, that I am committed to preserving that bottom line of your request. Fiscal responsibility requires no less. And thank you, Mr. Secretary, and thank you, Mr. Chairman.

The CHAIRMAN. I thank the gentleman from New Mexico.

The Chair recognizes the distinguished lady from Tennessee, Mrs. Lloyd.

Mrs. LLOYD. Thank you very much, Mr. Chairman. Happy St. Patrick's Day to all of you here, and welcome to you, Mr. Secretary, and we are happy that you can be before the committee. I think this is your second appearance, and I hope that you can appear before this committee more in the future, because we certainly would like to work with you in the formulation of a national energy policy.

I would like to add my approval and my support of the remarks of the Chairman. The time has come that we do need to develop a coherent national energy policy to take us through at least the next three decades.

I share his concern on the AVLIS program, that we do lack direction. I am also very concerned about what we're doing in our patent policy and the transfer of technology from our laboratories to the marketplace, and there is extreme delay.

I am proud of what we've been able to do at Oak Ridge. I think you know that I represent Oak Ridge, the home of the Oak Ridge National Laboratory, and we do hope that this technology transfer can be realized in the near future.

I know that you visited the city of Knoxville not long ago, and I hope that you will be able to visit us at Oak Ridge. The people would be mighty happy to see you there.

Thank you very much. Thank you, Mr. Chairman.

The CHAIRMAN. I thank the gentlelady from Tennessee.

Mr. Secretary, we are going to ask you to proceed. I just want to make one observation, if I may.

I've reviewed your testimony. I have to go to another hearing at 10:00 o'clock, and I'll have to be leaving. Mrs. Lloyd will take the chair.

What we intend is to work with you in the presentation that you've made, you know, so far. Some things we agree; some things we don't agree on. But ultimately, as Mrs. Lloyd points out, we are going to be holding substantive hearings on an overall view of the energy policy of the Nation. We are terribly concerned with the observation of what's happening on the oil situation and how that relates to the overall energy capabilities of this country, and we feel that until it can be at least stabilized, that when oil now gets to $18 a barrel, that concerns us, and it looks like there might be a crisis waiting to happen, and where we re coming on that.

We won't dwell too much on that today, but we will be taking that up later on as we go into it.

So again, we want to welcome you all, you and your good folks that are here, and you can go ahead and proceed, Mr. Secretary, as you wish.

STATEMENT OF HON. JOHN S. HERRINGTON, SECRETARY, U.S. DEPARTMENT OF ENERGY, WASHINGTON, DC, ACCOMPANIED BY MS. ELIZABETH SMEDLEY, CONTROLLER

Secretary HERRINGTON. Thank you, Mr. Chairman. I do have the people here to answer your questions and I'll do the best I can. They are, Mr. Jim Vaughan on the nuclear side, Jim Decker for Energy Research, Donna Fitzpatrick, in the Power Marketing and Conservation area, and Don Bauer for the Fossil Energy programs. They are all familiar to you and have worked with your staffs and will be responsive today as we always are.

I personally appreciate the opportunity to present our FY 1988 budget for the Department of Energy. This budget meets two very important objectives in my mind. One, it continues the strong support for essential programs in the Department's energy, science and defense mission areas and two, it contributes to the President's effort to reduce growth in the Federal budget and meet the Gramm-Rudman-Hollings deficit reductions.

The budget meets our increasing national security requirements and maintains our commitment to priority programs. Those priority programs to me are basic energy and science research, environment, safety, health, nuclear safeguards and security. Clean coal technology is also included and it is a very important part of our program.

Our FY 1988 budget of $13.9 billion supports a level of program activity which is essentially unchanged from FY 1987. However, the request for new budget authority is higher in 1988 because our funds carried over from the prior years into 1988 are much less than they were in 1987. The budget reflects recurring policy themes of this Administration that we have discussed before.

One, to confine the Federal support to activities which are properly the responsibility of the Federal Government. Two, provide technology transfer and obtain meaningful cost sharing. Three, divest assets which could be better managed by non-Federal entities.

Our budget reflects the Administration's strong support to frontier research and commitments to maintain and strengthen the nation's scientific leadership and technological competitiveness.

The most dramatic evidence of this commitment is President Ronald Reagan's recent decision to support the construction of the Superconducting Super Collider that was referred to by Congressman Lujan. This decision ensures that the United States will retain world leadership in high energy physics well into the next century, an area where we have been world leaders for many years.

The site selection process which was announced on February 10th should lead to a final site selection by January, 1989. The target completion date for this project is in 1996.

Other major projects contributing to these research efforts include the Continuous Electron Beam Accelerating Facility, known as CEBAF, in the Nuclear Physics Program and a Compact Ignition Tokamak in the Magnetic Fusion Energy Program.

The budget request for General Science appropriations, which supports CEBAF, the SSC, and other major high technology research facilities, is $815 million. This is a 13 percent increase over the FY 1987 funding level.

We continue the major effort we began in 1985 to identify and correct past problems in the environment, safety and health areas and to prevent current and future violations of safety and environmental standards. Our budget request for Environment, Safety and Health increases 13 percent to $70 million under this budget, with most of the increase applied to continuing the environmental survey and the technical safety appraisals of the Department's facilities.

The budget also continues our strong commitment to effective safeguards and securities at our facilities. It addresses the acid rain problem, which is another major effort of the Department, and an initiative which will receive increased emphasis in our effort to find ways to burn coal more cleanly, in addition to the number of advanced techniques already being studied in the Fossil Energy Research and Development budget. We are proposing to increase our Clean Coal Technology Program by drawing on funds in the Clean Coal Reserve to investigate promising retrofit, repowering and modernization technologies.

An initiative affecting the Power Marketing Administration is repayment reform. The objective is to have debt repayment proceed on a proper business-like basis. While this initiative will not affect the level of Federal funding in support of the PMA's, it will assure that repayment of the Federal investment occurs on a timely, stable predictable basis.

At this point, I'd like to discuss the budgets for selected program areas. The FY 1988 budget requests for Fossil Energy R&D and Conservation and Renewable Energy are consistent with our FY 1987 request. We believe that adequate funds are being directed to the highest priority activities and that the private sector can and should provide financial support for projects involving proprietary product or process development.

We are proposing to limit conservation grant funding to the $134 million derived from the escrow funds for the petroleum overcharge products. The States have received, you will be interested to know, $3 billion in the last two years in settlement of the oil pricing and allocation violations. We see no need for additional funds.

The budget request for nuclear waste disposal in FY 1988 is $500 million, which is consistent with the funding levels provided for support in FY 1986 and FY 1987. However, a draft mission plan amendment and a detailed budget supporting a $725 million program in FY 1988 have been prepared. Following a review by Congress, a budget amendment will be submitted for the $725 million, and is necessary to carry out the schedule described in our mission plan.

We recognize, and this is important, that there are particular areas of Congressional concern. It is our hope that the amendment and the mission plan will provide a suitable vehicle for Congress to provide any direction that it believes is needed for conduct of the program.

The FY 1988 budget request for Atomic Energy Defense Activities is $8.1 billion. In FY 1989, the request is $8.5 billion. The two-year budget was submitted for this account as required by the authorization legislation. The growth in this account averages 3 percent for each year over FY 1987 levels plus inflation.

SDI funding increases from $349 million in FY 1987, which includes $32 million of prior year funds, to $481 million in FY 1988.

The major emphasis of the Uranium Enrichment Program in FY 1988 is to reduce the cost of operation of the gaseous diffusion plants so that the Department's enrichment services can be competitive worldwide.

Through 1988, the Department of Energy's inventory of enriched uranium will continue to be drawn down so that customer delivery requirements can be met at a minimum production cost. The Department is requesting no funding for Atomic Vapor Laser Isotope Separation in FY 1988 and will continue to pursue the possible divestiture of the uranium enrichment enterprise.

Mr. Chairman, I believe that the budget I have summarized meets the Department's responsibilities in a manner that would recognize today's fiscal imperatives and tomorrow's anticipated needs.

I'd be pleased to answer any questions as would my Assistant Secretaries at this time. Thank you.

[The prepared statement of Secretary Herrington follows:]

STATEMENT OF

JOHN S. HERRINGTON
SECRETARY OF ENERGY

before the

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

MARCH 17, 1987

Statement of John S. Herrington
Secretary of Energy
FY 1988 Budget

Mr. Chairman and Members of the Committee, I appreciate the opportunity to present the FY 1988 budget for the Department of Energy. This budget was carefully developed to meet two objectives:

- continue to provide strong and effective financial support to essential programs in the Department's energy, science, and defense mission areas, and

- contribute to the overall Federal obligation to limit growth in the Federal budget and reduce the deficit.

We have achieved these objectives in this budget. The FY 1988 budget meets our increasing national security requirements, and maintains, and even deepens, our commitment to priority programs identified in past years, such as basic energy and science research, environment, safety and health, safeguards and security, and clean coal technology development. At the same time, the budget contributes strongly to the deficit reductions the law--and the American people--demand.

Before discussing details of the budget itself, I would like to describe the Department's policy and budget initiatives.

POLICY AND BUDGET INITIATIVES

The FY 1988 budget reflects certain recurring policy themes of this Administration which we strongly believe to be proper guidelines for responsible fiscal management of the Department of Energy. These include confining our support to those essential activities which are properly the responsibility of the Federal government, and withdrawing from activities where the justification for a Federal role is weak. In budget terms, this means several things: a continued emphasis on removing certain activities from Federal ownership and control and selling these assets to non-Federal entities; a rigorous drive to eliminate improper Federal subsidies for programs and projects which the private sector should be responsible for supporting; and further efforts to improve technology transfer and to secure meaningful cost sharing with private sector technology sponsors.

Programs where the justification for the Federal role is strong and clear are amply supported in this budget. These include such energy and science research areas as biological and environmental research, materials and chemical sciences, and high energy and nuclear physics, as well as our essential National defense activities. The strong commitment to these areas of research is part of a major Administration initiative to maintain and strengthen the Nation's scientific leadership and technological competitiveness. The most dramatic evidence of this commitment is the recent decision by President Reagan to support construction of the world's largest and most advanced particle accelerator, the Superconducting Super Collider. This decision ensures that the United States will retain world leadership in high energy physics. Other major projects supported in this budget that will facilitate frontier research efforts include the Continuous Electron Beam Accelerator Facility in the nuclear physics program and the Compact Ignition Tokamak in the magnetic fusion energy program.

The budget continues the major effort we began in 1985 to assure a standard of excellence at our facilities by addressing and correcting past safety and environmental problems while simultaneously seeking to prevent current and future violations of safety and environmental standards. The Department's commitment to effective safeguards and security at our facilities also continues to receive strong support.

The Department is applying substantial resources to solving the acid rain problem. A major environmental initiative which will receive increased emphasis is our effort to find ways to burn coal more cleanly. In addition to a number of advanced techniques being studied in our core fossil energy research and development budget, we are proposing to increase our Clean Coal Technology activities by drawing on funds in the Clean Coal Reserve budget account to investigate promising retrofit, repowering and modernization technologies.

Another significant proposal in the Department's FY 1988 budget concerns the Strategic Petroleum Reserve (SPR). At the end of FY 1987 the SPR will hold 534 million barrels of crude oil, in addition to the millions of barrels of stocks held by other nations and the private sector. Our budget proposes to return the fill rate from the present 75,000 barrels per day (BPD) to the previously mandated level of 35,000 BPD while permitting continued production from the Naval Petroleum Reserves. The difference between filling at 75,000 and 35,000 BPD in FY 1988 is only a minimal increase in protection secured at an estimated cost of approximately $225 million in additional FY 1988 outlays. In a time of fiscal constraint, it is our belief that the benefit is not worth the additional cost.

The Department is renewing its efforts to divest activities which are more appropriately managed by non-Federal entities. In particular, we are proposing legislation authorizing the sale of the Federal interest in Naval Petroleum Reserves (NPR) 1 and 3, and legislation authorizing a study of the feasibility of divestiture of the Southeastern Power Administration. Also, we will continue planning activities for the sale of the Alaska Power Administration. Neither the utility functions of the Power Marketing Administrations (PMAs) nor the oil field operations of the NPRs are fundamentally Federal in nature, and non-Federal entities could perform the same services with equal or greater efficiency.

For budgetary purposes, it is assumed that the two NPRs will be sold in FY 1988 for $3.3 billion, with $2.5 billion received in FY 1988 and $0.8 billion in FY 1989. Of course, the actual sales price will be determined by the competitive market. While the sales process is proceeding the FY 1988 budget proposes full funding for operation of the NPRs. The two PMAs are assumed to be sold in FY 1989. We will be working cooperatively with the Congress and in consultation with current PMA customers, and no implementation of PMA divestiture will occur until after subsequent Congressional review and approval.

Another initiative affecting the PMAs is repayment reform. Legislation will be proposed to ensure that repayment of the Federal investment in these facilities will proceed on a fixed amortization schedule as long as the PMAs remain under Federal control. While this initiative will not affect the level of Federal funding in support of the PMAs, it will assure that repayment of the Federal investment will occur on a timely, stable, and predictable basis.

With this as introduction, I will turn now to the FY 1988 budget request.

FY 1988 BUDGET SUMMARY

The FY 1988 budget for the Department of Energy is $13.9 billion. This budget supports a level of overall program activity which is essentially unchanged from FY 1987, but the request for new budget authority is higher. This is because in FY 1987 our programs benefit from substantial amounts of funds carried over from prior years, including approximately $690 million made available to nuclear and non-nuclear technologies in the Energy Supply Research and Development appropriation account.

At this point, I would like to discuss the budgets for selected program areas.

GENERAL SCIENCE

The budget request for the General Science appropriation of approximately $815 million is a 13 percent increase over the FY 1987 funding level. This sizeable increase reflects the Administration's belief that the key to maintaining the Nation's competitive edge in an increasingly technological world includes expanded support for frontier research. The programs that comprise the General Science appropriation, High Energy Physics and Nuclear Physics, aim at improving our understanding of the fundamental nature of matter and energy. Powerful accelerators and other advanced research facilities are required to carry out this research. The substantial increase in this appropriation is due mainly to higher funding proposed for research and development and the use of new accelerators and experimental facilities, plus construction funding for the Continuous Electron Beam Accelerator Facility in Newport News, Virginia.

The highlight of the High Energy Physics program budget request is the proposed Superconducting Super Collider (SSC) project. With an energy level 20 times greater than currently available anywhere in the world, the SSC will probe deeply into the fundamental building blocks of matter. The total project cost of the Super Collider, with its racetrack-shaped tunnel 52 miles in circumference, is $4.4 billion in FY 1988 dollars. This includes the cost of detectors, computers, and preoperation expenses, as well as construction of the facility and the approximately 10 thousand superconducting magnets used to guide the protons into head-on collisions. In FY 1988, $35 million is requested for the SSC, which includes $10 million for construction activities and $25 million for research and development.

ENVIRONMENT

One of my highest priorities has been to upgrade the environment, safety and health activities of the Department of Energy. I wish to ensure that our facilities comply with all applicable environmental statutes and regulations, and that the health and safety of the public, our employees, and our contractors is protected. The budget for the Environment, Safety and Health program is $70 million, which represents a 13 percent increase over the FY 1987 level. A significant part of that funding increase will be applied to continuing the

Environmental Survey and the Technical Safety Appraisals of the Department's facilities. These programs are designed to identify and prioritize environmental problems and areas of risk so that corrective actions might be carried out most effectively.

Another environmental program which shows significant growth is Biological and Environmental Research. The budget request of $218 million in FY 1988 is 12 percent above the FY 1987 level. This program makes use of the Department's unique capabilities in the life sciences to identify and assess the long-term health effects and environmental consequences of energy development and use. A significantly increased radon research program is included, as is an enhanced effort to better understand the structure and function of genes. Research on the "greenhouse effect" is also supported in this program.

CLEAN COAL TECHNOLOGY

A major initiative in this budget is the significant expansion of the Clean Coal Technology program, which is designed to support demonstrations of technologies that show promise for burning coal cleanly. Our ability to make full use of our vast coal reserves depends in large part on being able to use coal in a manner that is both environmentally acceptable and economically viable.

The present three-year program envisions the Department proceeding with nine projects selected last summer for negotiation of cooperative agreements. It makes use of $396 million in previously appropriated funds. In FY 1988, the Department is proposing to begin applying the remaining $350 million in the Clean Coal Technology Reserve, starting with an additional $50 million in FY 1988. An advance appropriation of $100 million in FY 1989 is also requested.

Two additional competitive rounds of demonstration projects are planned in the 1988-1992 timeframe. Technologies which can retrofit, modernize, or repower existing coal burning facilities would be eligible for consideration in both rounds. These demonstrations would be targeted closely to recommendations in the Joint Report of the Special Envoys on Acid Rain. A feature of the Clean Coal Technology program is that the industrial sponsors of the technology must provide at least 50 percent cost-sharing.

NUCLEAR ENERGY

Research and development activities in support of nuclear energy technologies are funded at $336 million, slightly above the FY 1987 level of activity. The program mix includes a balanced research and development program for both civilian nuclear power and space and defense nuclear energy sources. The emphasis begun in FY 1987 on Space and Defense Power Systems continues. Its budget doubles in FY 1988, primarily as a result of the increase for the design and construction phase of the Ground Engineering System for the SP-100 space reactor power system.

Support for civilian nuclear power continues in the Light Water Reactor and Advanced Reactor Research and Development programs. Research on fuel cycle improvements and on advanced concepts as alternatives to current power reactor systems will be focussed more sharply, with emphasis in FY 1988 on modular reactor systems that offer passive safety features and the potential for improved economic performance. An international program in support of the high-temperature gas reactor will also be conducted.

MAGNETIC FUSION

The budget for Magnetic Fusion is $346 million. Although the funding profile is essentially level, continued progress is expected in FY 1988 in this program. The principal new initiative will be the start of construction of the Compact Ignition Tokomak at Princeton University. The device is designed to prove that a plasma can be ignited and burn without continuous external heating.

BASIC ENERGY SCIENCES

The Basic Energy Sciences program performs generic, long-range research in support of both nuclear and non-nuclear technologies. Research efforts involve the physical and biological sciences, engineering, applied mathematics, and geosciences. In FY 1988, higher funding is proposed for the highest priority research areas and to maintain the level of operations in the Department's major facilities at the Argonne, Brookhaven, Los Alamos, and Oak Ridge National Laboratories and the Stanford Synchrotron Radiation Laboratory. The FY 1988 budget request of $479 million is below the FY 1987 appropriated level, but the FY 1987 appropriation included approximately $62 million for several one-time university construction projects.

FOSSIL, CONSERVATION, AND SOLAR AND OTHER RENEWABLES

The FY 1988 budget requests for Fossil Energy, Conservation Research and Development, and Solar and Other Renewables are consistent with our FY 1987 request but well below the appropriated levels. It is the Department's firm belief that Federal funds must be directed only at the highest priority research and development needs where funding support from industry cannot reasonably be expected. We believe that the private sector can, and should, provide financial support for projects involving proprietary product or process development. Our FY 1988 request is consistent with these objectives.

Of the $169 million proposed for Fossil Energy Research and Development, $109 million is directed towards coal research. The major thrust is in acid rain-related technologies, primarily in the control technology and coal preparation and the combustion systems program areas. High priority research efforts will also be continued in petroleum and unconventional natural gas recovery.

Conservation has made important contributions to the Nation's improved energy posture. The emphasis of energy conservation research and development is to assist the private sector by conducting research targeted at expanding the technology base upon which industry can draw in developing new products and processes for the marketplace.

The budget for Conservation Research and Development is $80 million, divided principally among the Industry ($16 million), Transportation ($22 million), and Buildings and Community Systems ($15 million) end-user program areas; and the Multisector program ($20 million), which supports crosscutting research and development in such areas as combustion and thermal sciences, materials sciences, biocatalysis, and tribology.

The focus of the Solar and Other Renewables energy program is on supporting research and development that will strengthen the technology base on which industry can draw in developing new products and processes for the commercial market.

The budget for Solar and Other Renewables is $94 million, and is focussed primarily on Solar Energy ($71 million) and Geothermal ($16 million) technologies. Within Solar Energy, the principal program components are photovoltaics, solar thermal, and biofuels energy systems. Cost sharing and technology transfer is actively being pursued in each area.

The Fossil Energy, Conservation, and Solar program areas are all participating in the Cooperative Research and Development Venture initiative, which is currently in the exploratory stages. This innovative effort seeks to make it easier for competing companies to pool their research and development efforts in pre-competitive areas, with the Federal government joining these industry consortia as a minority partner. The base technology developed in this way will become an input to each partner's own proprietary product and process developments. In addition to the benefits to the taxpayer from the substantial level of industry cost sharing, technology transfer should be much improved by having the companies expected to exploit and deploy the technologies involved in the research from the beginning.

In FY 1988, $17 million will be proposed for these ventures; $7 million for Fossil Energy and $5 million each for Conservation and Solar. The President's budget does not yet include these figures; they will go forward as a budget amendment as soon as consultations with industry groups are concluded. At the present time, it appears that likely technology candidates for the cooperative venture program include, but are not limited to, extraction and coal utilization technologies in Fossil Energy; steel, papermaking, building materials, and high-temperature ceramics in Conservation; and photovoltaic and geothermal technology development in Solar and Other Renewables.

WASTE ACTIVITIES

Safe storage, handling, and disposal of civilian and defense nuclear waste and cleanup of contaminated facilities has long been a major priority of the Department of Energy. The Department of Energy's nuclear waste programs are managed by the Defense Programs, Nuclear Energy, and Civilian Radioactive Waste Management offices. In FY 1988, almost $1.6 billion is requested for waste activities, an increase of $113 million from the FY 1987 level.

The largest funding component, $811 million, is for Defense Waste Management, which shows significant growth over FY 1987. Major increases are proposed for the Defense Waste Processing Facility at the Savannah River Plant in South Carolina and the Waste Isolation Pilot Plant in New Mexico, which are scheduled to become operational in the FY 1989-1990 time frame. The budget also provides for initiation of the Waste Vitrification facility at the Hanford, Washington site.

The purpose of activities conducted under the Nuclear Waste Disposal Fund program, managed by the Office of Civilian Radioactive Waste Management, is to provide for the permanent and safe disposal of spent nuclear fuel and high-level radioactive waste. The budget request for FY 1988 is $500 million, which is consistent with the funding levels provided in fiscal years 1986 and 1987. However, an amendment to the program's Mission Plan and a detailed budget supporting a $725 million program in FY 1988 have been prepared. Following review by Congress, a budget amendment will be submitted for the $725 million program necessary to carry out the schedule described in the Mission Plan amendment. It is our hope that the amendment to the Mission Plan will provide a suitable vehicle for Congress to provide direction it believes is needed for conduct of the program.

The other major element within the waste activities category is the Remedial Action program in the Nuclear Energy organization, which is concerned with waste stabilization, decontamination, and decommissioning of various Federal and legislatively mandated non-Federal facilities and sites. After a number of years of rapid growth as new sites were identified, site surveys were completed, and environmental mitigation efforts begun, the FY 1988 budget of $252 million maintains an effective program of cleanup activities at existing sites.

DEFENSE ACTIVITIES

The FY 1988 budget request for the Atomic Energy Defense Activities appropriation account is $8.1 billion. In FY 1989, the request is $8.5 billion. Excluding the effect of anticipated inflation, the growth in this account averages 3 percent each year over the FY 1987 level.

The FY 1988 budget includes $0.8 billion for Defense Waste Management, as discussed above. It also includes $2.1 billion for Weapons Research, Development, and Testing; $2.4 billion for Weapons Production; $1.9 billion for production of special nuclear materials; and $0.6 billion for Naval Reactors Development, and $0.2 billion for other defense activities.

The Weapons Research, Development, and Testing budget increases in FY 1988, due in part to significantly increased funding in support of the Strategic Defense Initiative (SDI). SDI funding increases from $349 million in FY 1987, which includes $32 million of prior year funds, to $481 million in FY 1988.

Weapons Production and Materials Production show only modest increases over the previous budget levels. The Department's defense production activities respond directly to the requirements of the Defense Department. The FY 1988 budget assumes delivery of six different nuclear weapons systems, and the beginning of pre-production construction activity for the Small Intercontinental Ballistic Missile warhead. The Materials Production budget assumes operation of the production reactors at the Savannah River facility in South Carolina, and a full year of normal operation for the N-Reactor at Hanford, Washington, which is currently in a stand-down status for safety improvements.

STRATEGIC PETROLEUM RESERVE

The budget for the Strategic Petroleum Reserve (SPR) is $270 million; $142 million for facilities development and management and $128 million for oil acquisition and transportation. The facilities funds will be used to continue operation and maintenance of the Reserve and permit continuation of activities to improve the system's drawdown capability. Construction activities at the Bayou Choctaw and Big Hill sites will be completed during FY 1988 using funding from prior years.

The oil acquisition funding request will permit an FY 1988 fill rate of 35,000 barrels per day (BPD). The budget includes appropriation language proposing this fill rate in lieu of the currently mandated rate of 75,000 BPD. Supporting authorization legislation also will be submitted shortly. The SPR will hold 534 million barrels of crude oil at the end of FY 1987. While the Administration remains committed to achieving a full 750 million barrel SPR, it believes that the pace for reaching that goal must be determined, in large part, by fiscal priorities. Adhering to the 75,000 BPD fill rate is estimated to increase FY 1988 outlays by about $225 million while having only a minimal effect on the level of protection offered by the SPR.

URANIUM ENRICHMENT

The major emphasis in the Uranium Enrichment program in FY 1988 is to reduce the cost of operation of the gaseous diffusion plants (GDPs), so that the Department's enrichment services become competitive in the world market. The budget request of $1.1 billion is almost 13 percent below the FY 1987 program level, and reflects further reductions in the production levels of the GDPs. Through 1988, DOE's inventory of enriched uranium will continue to be drawn down to enable the enterprise to meet customer delivery requirements at minimum production cost.

The Department is not requesting FY 1988 funding for the Atomic Vapor Laser Isotope Separation process, and will continue to pursue the possible divestiture of the Uranium Enrichment enterprise. In FY 1988, $231 million in excess revenues will accrue to the Treasury in partial repayment of the unrecovered government investment in enrichment facilities.

TWO-YEAR BUDGET

As a result of recently enacted Defense Authorization legislation, the Administration is submitting a two-year budget for all activities contained in Budget function 050 (Defense). Consequently, the Department of Energy is requesting funds for FY 1988 and FY 1989 for the Atomic Energy Defense Activities appropriation account. The average real growth in this account over the two year period is three percent per year.

Mr. Chairman, I believe that the budget I have summarized meets the Department's responsibilities in its several mission areas in a manner that recognizes both today's fiscal imperatives and tomorrow's anticipated needs.

DISCUSSION

Mrs. **Lloyd** [presiding]. Thank you very much, Mr. Secretary. We are going to abide by a five-minute rule our first trip around, and then come back for a second round of questioning, so that everybody will have an opportunity to take part in the hearings today.

There are several areas of concern that I have, of course, and I think I'd like to start today by discussing the MRS with you.

Of course, your Department has consistently stated that they want to build the MRS, but yet the cost of this facility continues to escalate, as there is more information on the MRS. I think that your own internal estimates have gone up 45 percent since December of 1985 to a level of $2.9 billion, Mr. Secretary, and it's my understanding that this does not include such considerations as payment in lieu of taxes, the impact assistance, and the cooperation and consultant costs, or licensing, or spent fuel transportation.

Now these are big-ticket items here. They aren't minor expenses. But they aren't even included in our $2.9 billion figure.

Now this will be paid by the utility ratepayers across the country. So what justification can you make that this MRS is going to be cost-effective?

Secretary **Herrington**. I think in evaluating the whole waste disposal system, whether it's the permanent repository in the West or whether it is the MRS, and the transportation system, cost, although important, is not the biggest factor. The biggest factor——

Mrs. **Lloyd**. The cost is not the factor?

Secretary **Herrington**. Is not the biggest factor. The most important factor in the waste disposal system is, I think, the safety of it, how it is handled environmentally, and whether it is, in fact, a system that will work.

There has been, in fact, cost growth in MRS. I'd be happy to submit the records. I don't have the figures on the top of my head like you did for the MRS, nor on how they relate to the impact aid.

In evaluating waste sites, we do put a high value on cost, but it is not the most important.

Mrs. **Lloyd**. You consider the safety, whether or not it will work, to be the two considerations, and money is third?

Secretary **Herrington**. Certainly two of the most important. I don't rank those. I don't rank them with cost. But certainly I do not put cost as number one. The importance of the project——

Mrs. **Lloyd**. Well, correct me, Mr. Secretary, if I'm wrong, but it's my understanding that the waste program with an MRS is going to cost more than a waste program without the MRS.

Now if we have a waste system without an MRS, that it will be less expensive than—I just don't see why no MRS is not the better option.

Secretary **Herrington**. I would agree with you that the waste program without MRS is less costly.

Mrs. **Lloyd**. Well, let me put it in a different way. A primary alternative to the option, as you know, of building an MRS is for the Government to accept this, to take title to the spent fuel in 1998, and then to store it in dry cask storage at the various reactor sites around the Nation; isn't this correct?

Secretary **Herrington**. Yes.

Mrs. LLOYD. Well, if this is a less expensive option for the Nation, then what are the reasons for not selecting this option?

Secretary HERRINGTON. I think the waste plan and Congressional intent recognize that we cannot indefinitely store high-level hazardous waste, in pools of water around the country.

Mrs. LLOYD. I was talking about the dry cask storage.

Secretary HERRINGTON. I understand. The important thing is to get the waste to a permanent repository site.

Mrs. LLOYD. Well, I agree with you, to a permanent repository site. But I hope to goodness an MRS is not going to be considered a permanent repository site at the beginning.

Secretary HERRINGTON. I think we're pretty clear on the record many times that the MRS is not intended to, nor will it become a permanent waste repository site.

Mrs. LLOYD. Well, some of us are not too sure of that.

I think my time—Mr. Lujan?

Mr. LUJAN. Thank you, Madam Chairman.

I have three kind of quick questions, Mr. Secretary. As you heard in the chairman's opening statement and from some other people that are concerned about the Super Collider crowding out funding for other energy R&D projects, and it was my understanding that the Super Collider will be considered outside the regular budget; is that correct? Can you assure us of that, Mr. Secretary?

Secretary HERRINGTON. Yes. Before the Super Collider was taken to the President for a decision, we made sure that the other scientific disciplines had been taken care of in an overall science program. You will see the budget of the National Science Foundation doubling in five years—$10 billion in new money over the next ten years. I think over the last period of time since 1980, you can make a good case that the National Science Foundation budget will be tripled.

That does not count things such as CEBAF, which I mentioned in the opening statement or the Compact Ignition Tokamak experiment and the science centers that are proposed to be established. I believe that we are treating these in a balanced manner. Certainly high energy physics is a more expensive discipline, but I think that we have reached a balanced result.

Mr. LUJAN. So that in essence the bottom line is that, no, the Super Collider initiative is not going to crowd out other energy R&D projects?

Secretary HERRINGTON. My feeling is it will not.

Mr. LUJAN. Okay, thank you.

A couple of quick questions. Again, we see high-temperature gas reactor down to close-out money. We look at that every year, and every year we come back and add—take it up to $25 or $30 million.

My feeling all along has been that the HTGR is safer. Other people say that. We've got a good market overseas for it, that it's not that far-term. It seems like a rather attractive and has seemed like a rather attractive possibility to me in the past.

Why do we keep—the Administration keep cutting down funds to almost a close-out of the program?

Secretary HERRINGTON. I think if I had to give one reason, it would be budgetary. There is nothing inherently wrong with the HTGR.

We are forced to make choices. This is a very popular program on the Hill. I understand that. But when you're making choices between reactor programs in the Department of Energy with limited money, you are forced to pick one over the other. And I think that's the basic reason for it.

You should note—and I think it's no secret to anybody here—that there have been no new reactors ordered in the United States since 1978. The South Koreans have recently indicated that they will order two American reactors, but that's the first business I've seen for this industry in quite awhile, and the contracts are not signed yet.

We were in tough competition with the French and the West Germans. The finest export program today that I've seen is that of Japanese. I think we're going to be hard-pressed to export our technology given the current state of the industry.

Mr. LUJAN. The final question that I have, you talk about privatizing uranium enrichment. When is that legislation coming up, and can you give me some plans, what we're looking at?

Secretary HERRINGTON. I have confirmed that we are making a recommendation by the 30th of the month. We have not intended to send legislation yet. It is an activity that I believe should be in the private sector, but unfortunately there are a great deal of problems in the enrichment enterprise, which I'd be happy to go into, that will enter into the question before we can privatize.

Mr. LUJAN. But it is the intention of the Department to privatize uranium enrichment as we move along?

Secretary HERRINGTON. We are supportive of that proposition, yes.

Mr. LUJAN. Okay. Thank you, Madam Chairman.

Mrs. LLOYD. Thank you very much, Mr. Lujan.

Miss Schneider?

Mr. SENSENBRENNER. Mr. Sensenbrenner yields his time to the gentleperson from Rhode Island. [Laughter.]

Mrs. LLOYD. We've got a real love-in over here this morning.

Miss SCHNEIDER. So I get double time, so I'm ready. I can use it.

Mr. Secretary, you have, in previous testimony before our committee and numerous other committees here in Congress, including today, you have said that you are forced to make choices. You have said that it is necessary to pick the winners and the losers.

Who is the winner in this budget?

Secretary HERRINGTON. In which particular area?

Miss SCHNEIDER. In your entire energy budget, who is the greatest beneficiary of our Federal tax dollars?

Secretary HERRINGTON. I would say the American taxpayer.

Miss SCHNEIDER. I would say that the consumer organizations and the national taxpayer organizations are considering targeting you as one of the most anti-consumer members of the Administration.

Let me give you a breakdown on specifics. The budget that you are proposing for 1988 is $1.2 billion—excuse me—it's been increased by $1.2 billion to $13.9 billion, which is nearly a 10 percent increase.

Overall, the runaway winner is military nuclear research with $6.8 billion of the budget. The other obvious winner is energy supply with nearly $2 billion. Civilian nuclear power gets the lion's share of supply R&D at nearly half a billion dollars.

Secretary HERRINGTON. That's civilian nuclear supply?

Miss SCHNEIDER. Yes. Of R&D.

Now those are the winners. The clear losers are energy efficiency and renewable resources. Conservation R&D is reduced to a mere $80 million. Renewable R&D is reduced to a measly $75 million. And you have to—can't help but ask by what criteria do you choose these winners and losers. And I can only find one very bizarre criteria, and that is that among the five major energy R&D programs—fossil, fission, fusion, conservation, and renewables—conservation and renewables have each received the least amount of Federal R&D funds since the 1973 Arab oil embargo, and so by some kind of perverse logic, apparently that trend has continued by providing them with the least support.

Now what's interesting is that in the New York Times, under the Business Section of the newspaper, there is an article that says, "Making Power Cost-Effective. As demand increases, so does the cost."

Now it seems to me that the Secretary of Energy's primary responsibility would be to reduce the cost to the consumer, to provide the supply that is available.

Well, what I also find interesting is that you mentioned the word "competitiveness" in your testimony, and the chairman had mentioned competitiveness. And who is it that we're competing against but Japan, Germany, France, et cetera?

Well, when we do a comparison side by side, we see that in Western Europe, they increased their oil consumption by 3.5 percent in 1986. The United States, however, used 14 percent more heavy fuel oil in the first ten months of last year, and Japan, rather than increasing their consumption, reduced their consumption by 10 percent.

That gives you an idea of the playing field that we're dealing with.

So my question to you is, since it appears that the U.S. utilities are very proud—and in this article, it says that the utilities these days are talking about the spanking new plants that they did not build—in other words, how they are able to save that capital, so it could be redirected into the marketplace—the utilities are considering a variety of new strategies, most of these relying on energy efficiency or load management.

This morning in the Washington Post, you mentioned that you are going to attempt to distort the marketplace once again by suggesting incentives to reduce oil imports. The only tax incentives that were mentioned were for the oil suppliers, in order to spur drilling.

Are there any other proposals that you have for tax incentives, where you feel that you can level this playing field?

Secretary HERRINGTON. Well, you've hit the whole thing.

Miss SCHNEIDER. I try to be comprehensive.

Secretary HERRINGTON. And I think you have been. I don't know where to start on the answer, but I'll keep it brief, because I know your limit on time.

Miss SCHNEIDER. That's all right. I have Mr. Sensenbrenner's time, so——

Secretary HERRINGTON. Oh, that's right.

The CHAIRMAN. We're on Mr. Sensenbrenner's.

Miss SCHNEIDER. We're on it now. Okay.

Secretary HERRINGTON. I promise not to take all his time.

Miss SCHNEIDER. Okay.

Secretary HERRINGTON. I think you are quite correct that our military budget has gone up, and rightly so, because the President's number one initiative, obviously, is the SDI program, which we are heavily involved in, although the Energy Department only does 10 percent of it, which is in the nuclear sector.

The biggest winner in the budget, I think you might have missed something. The biggest winner in the budget for getting money is Clean Coal Technology, without a doubt. There is no close competitor to Clean Coal Technology. We have a $750 million Clean Coal Demonstration Program that's been put in the budget with Fossil Energy R&D and probably another huge request coming, based on acid rain. So Clean Coal walks away with the prize, if you're looking for winners and losers.

Miss SCHNEIDER. But my emphasis is on R&D, not on the demonstration plants themselves, basically R&D.

Secretary HERRINGTON. It's the same thing. We are testing new technologies. You have said that the conservation/energy efficiency R&D budget is down. I think we sent to Congress over $87 million in rescissions for buildings and pork barrel projects at universities around the country. The rescissions were not acted on and they are now back in the budget.

You will have to agree with me that constructing buildings at universities sure as heck is not energy conservation R&D, yet it's in that budget.

Miss SCHNEIDER. And so how are those funds being, then, redirected for conservation purposes?

Secretary HERRINGTON. I'm not—let me just finish, please.

I certainly can't disagree with the New York Times or the Washington Post. Their credentials are great. But you cannot say that we haven't made progress. The facts in the new energy study that is out today are that energy consumption in this country is dramatically down from 1973, and at the same time that our GNP and economy is skyrocketing up.

I stated a minute ago that in the last two years, the Federal Government has given $3 billion to States in petroleum overcharge refunds from the Economic Regulatory Administration. You also have a $1.8 billion program at another department for the same thing. I think that's enough money.

We are finding States that can't spend that money. They are building bridges, buying school buses. It goes on and on.

Miss SCHNEIDER. Well, maybe we should divert some of that, because my state is only going to be supplying half of the people that are in need, from the oil overcharge money.

But that's incidental. I'm not being parochial here. I'm trying to be global, and my comments and the statistics seem to contradict the thrust of the Department of Energy.

Secretary **Herrington**. The energy study that is coming out today is a huge study. It has private sector input and Federal input. It's had intergovernmental support. I think it's probably—and it's not because I had anything to do with it—but it's the best work of the Department in a long time on where we are going globally.

It shows that by 1995, based on whether you take a high-price scenario or a low-price scenario, the country will be importing somewhere between eight and ten million barrels of oil per day. Today, we're importing about 5.3.

At the same time, our production this month at Prudhoe Bay will be peaking and starting down. Last year, we lost 800,000 barrels a day in domestic petroleum production. This coming year, we estimate about 400,000 barrels.

We have a serious problem with domestic oil supplies, and we are not closing that gap. And if we don't, there is no transition into these new types of fuels that we're going to be using.

Miss **Schneider**. Do you realize that there is a way to close that oil gap, and that is through the energy technology—energy efficiency technologies that we already have on hand?

You are mentioning the report that's coming out today. The President's Commission on Industrial Competitiveness reported two years ago that the Federal Government needs to strongly support civilian R&D that spurs economic productivity that will ensure economic preeminence. They go on to say that this country has already lost seven out of the ten markets in energy technology, where we have lost to the Japanese—refrigeration, motors, materials, you name it—we are losing that market.

Your focus seems to be strictly on oil import and export. But the reason we have been successful in reducing our consumption over the last ten years is because of energy efficiency investments.

Now we stand—and that totals about $150 billion—we could save the taxpayer $100 billion next year, if we were to implement some of the energy efficiency technologies that it looks like we're going to have to be buying from Japan. But yet this budget does not reflect any awareness, knowledge, or even interest, for that matter. It seems that your interest is more in traveling to South Korea to try to sell them our hardware.

Secretary **Herrington**. I think both are important, but do not make the mistake of measuring energy conservation and efficiency in the United States by how many Federal dollars you spend in a program.

Miss **Schneider**. Definitely.

Secretary **Herrington**. There are some great State programs. Energy conservation and efficiency are well established in our building codes, our plant standards, our electric motors that we are building and our automobiles.

There has been great progress and it has been very successful but at this point you don't just put more Federal money into it and get more results out of it on a proportionate basis.

Miss **Schneider**. Well, I am afraid that for every dollar that you invest in energy conservation the return is $50.00 on that investment. Can you state for me what the dollar investment is in the other technologies that you are promoting and what the return to the taxpayer is?

Secretary **Herrington**. Donna, would you mind responding to that question?

[The information follows:]

Payback of Conservation R&D

Conservation programs pursue a broad range of efforts which emphasize long-term and high-risk efforts where it is unlikely that the private sector will pursue the work by itself. The payback of conservation research and development to the Nation, which Congresswoman Schneider has estimated at 50 to 1, is difficult to estimate. Potential energy savings vary greatly from technology to technology, and it is difficult to provide an estimate that applies evenly across the conservation programs. We believe that carefully targeted applied research and continuing basic research efforts will provide a range of energy efficient technology opportunities for the future. In the Industrial Energy Conservation Program, for example, where approximately 23 efforts have reached commercialization, the yearly benefits (in energy savings) now amount to over $150 million on an initial investment of around $42 million.

Miss **Schneider**. I would like you to just list, for our investment of the Federal R&D in coal, our investment in nuclear, our investment in other technologies. I can state for you that for conservation, it is a dollar and $50.00 return.

Secretary **Herrington**. On the conservation issue, I would like to defer to Donna Fitzpatrick, our Assistant Secretary for Conservation and Renewable Energy.

Miss **Schneider**. The problem is that I am not interested in conservation. I know how much we need to invest in order to get our return. I would like to know what the return on the dollar is on the other technologies that you seem to be supporting even more so.

Secretary **Herrington**. I would be happy to submit that for the record. If we could comment on the conservation part of it, I would appreciate it.

Miss **Schneider**. I am afraid my time is up.

Mr. **Mineta**. Madam Chairwoman, if I have time, I would like to yield it to our colleague. I would like to yield my time to my colleague to continue the questioning.

Miss **Schneider**. Thank you, but I really do not want to have my time taken up by reiterating the conservation edge of the budget because I am already familiar with that but I am interested in knowing if you have, in fact, done a cost-benefit analysis of taking the taxpayers' hard earned dollars and putting a dollar in for conservation, you get $50.00 in return.

If you put a dollar into those other technologies, you are not aware of what the return is on that investment and so I ask you, how can you comfortably come before this committee and suggest that we endorse this budget that you are proposing?

Secretary **Herrington**. Well, I think that you have made certain allegations on the conservation side that I would like to answer and I would like to have Miss Fitzpatrick answer, if that is appropriate.

I would be happy to submit the cost benefit analysis on the other technologies.

Miss **Schneider**. I don't know what the question is so I don't know that there is an answer.

Mr. **Hall**. Madam Chairman, I think I am next up and I would certainly yield some time. I think the gentlelady should have an answer and I expect the Secretary probably has an answer and I hope when he gives her the answer that he cranks into that computer the importance of national defense and jobs and many other things.

Mrs. **Lloyd**. Do you want to yield time on the conservation issue or do you want to address the conservation issue on your time?

Mr. **Hall**. I will yield some time on it. I don't want to, but I will.

Mrs. **Lloyd**. Mr. Secretary, two more minutes have been given to you to answer the question.

Secretary **Herrington**. I am going to have to ask that the question be restated.

Miss **Schneider**. The question that I asked is for every hard earned taxpayers' dollar that is invested in energy conservation, there is a $50.00 return on the investment. What is the return on the investment for all of the other line items that are included in your budget thereby, how do you justify the winners and the losers in setting priorities for this budget?

[The information follows:]

BUDGET PRIORITIES

Return on investment (ROI) is a generally accepted method of determining program selection in the private sector. However, it is only part of the criteria used in justifying Federal programs. The pursuit of Federal programs goes far beyond the mathematical calculations of an ROI analysis. The favorable ROI on energy conservation programs is a greater incentive for private investment while longer-term, higher-risk R&D, which has a less favorable ROI, has generally been accepted as more appropriate for a Federal role.

The FY 1988 budget of the Department of Energy fully meets the funding requiements of essential programs in the Department's energy, science, and defense mission areas, while contributing to the President's efforts to reduce growth in Federal spending and to support the overall Federal mandate for deficit reduction to meet the requirements of the Balanced Budget and Emergency Deficit Control Act of 1985 (Gramm-Rudman-Hollings).

A principal objective of this budget is to ensure that Federal funding is proposed only for those activities which are clearly the responsibility of the Federal Government, or where significant costs sharing from the private sector can be expected. Where the justification for a continued Federal role is not substantial, the Department is proposing either to withdraw from further participation or, where Federal assets are involved, to seek authority to sell these assets to non-Federal entities.

The FY 1988 budget includes a strong commitment to basic science research; a continuation of programs for enhancing public health and safety and environmental protection at the Department's facilities; increased funding for the Clean Coal Technology Program aimed at addressing the acid rain problem; repayment reform for the Power Marketing Administration; and transfer of attractive technologies to the private sector for possible commercial development and deployment.

Secretary **Herrington**. I would like to submit that for the record to save you time.

Miss **Schneider**. All right.

Mrs. **Lloyd**. You will be permitted another round of questions.

Miss **Schneider**. All right, fine.

Mrs. **Lloyd**. Mr. Morrison.

Mr. **Morrison**. Thank you, Madam Chairman. In some areas of the country, nuclear waste has become bigger than life as you are aware. I just want to run through with you where you think we are. I know we have a revised Mission Plan up on the Hill which addresses several things that have happened in the last couple of years.

I understand that there is potentially a request for additional funding for the Nuclear Waste Program. Let me also set the stage though by saying that we are seeing every day new bills introduced which would change the Nuclear Waste Policy Act by permanently excluding the second round of sites and would lift the cap that is on the volume limits on the first site but Congress has not acted on anything.

The question to you is: Do you sense that this nuclear waste process is unraveling or do you believe that the Nuclear Waste Policy Act will remain untouched and that your revised Mission Plan will be blessed, in essence, by the Congress?

Secretary HERRINGTON. I continue to feel that this is obviously very controversial. There are two things that we can say about it. Number one, we need a nuclear waste site on a permanent repository basis. Number two, nobody wants it. It is highly political and very difficult.

I do not feel the process is unraveling. I see a clear end to it. I think we are at a pivotal year and I would say a pivotal spring and summer in this program.

Our options are clear. We have said to Congress in a Mission Plan, which we are required under law to give, that we see two things. We see, number one, that we will not reach 70,000 metric tons at the current rate of generation of waste until far beyond the time that we thought we would when Congress put the law together.

We have 45,000 metric tons of civilian high level waste today and we have 15,000 metric tons of defense waste. That does not add up to 70,000. There are no new plants being built. At the current rate of generation, it will be quite a while before we get to that level.

Given that and the time that we know that it takes to build the repository, we don't know when we are going to need a second repository and we don't need to go out and spend between $700 and $900 million dollars today to find the site for that second repository.

So on two grounds, we are saying the decision on whether a second repository should be postponed as to site-specific work—and I am being very careful with my wording here, we are not saying cancel it—we are not saying anything except that site-specific work can be deferred until 1995.

In accordance with the law, we have put this in writing and given it to the Hill as our recommendation. If Congress acts on this Mission Plan Amendment, we will then defer the second repository site specific work until 1995.

We are also behind in the program because of the enormous controversy and public input that has taken place. So we have asked to slip the schedule five years.

Finally, if Congress acts to amend this plan, we will move on the Mission Plan. If Congress does not act on the Mission Plan and I fully expect them to, but if they say, "No, we like the original law," then we are bound by the original law and by September 30, we will be back working on the second repository site specific work in accordance with the original schedule.

It will still be difficult to meet the 1998 goal under any circumstances, but we will do our best to try to meet that deadline.

Mr. MORRISON. Do you plan to come to the Hill for additional funding? I notice that the funding that you propose is one million dollars over last year's level but we have understood that there was potentially a request for additional funds to get on with the characterization at the first round of sites.

Secretary HERRINGTON. Our amended budget will be $725 million. We are at $500 million now. To carry out the Mission Plan, we would need the extra $225 million.

Mr. MORRISON. Will the Department resist any efforts to amend the Nuclear Waste Policy Act such as those plans being introduced now to drop the second round of sites, to lift the cap?

Secretary HERRINGTON. I have to look at what the proposals state when they come up. What I would like to see happen as Secretary of Energy is to have Congress endorse our Mission Plan Amendment.

I think it makes fiscal sense and programmatic sense. Anything that deviates from that, I simply do not want to speculate on. I have to see what happens between now and the end of the summer.

I think from our legal opinions and my own reading of the program, which is controversial because I have been accused of going outside the program, my own reading of the program is that all Congress has to do is endorse the Mission Plan Amendment and we can proceed under the current Nuclear Waste Act.

I am not advocating an amendment to the Act at this point.

Mr. MORRISON. Thank you, Mr. Secretary, I appreciate that.

Mrs. LLOYD. Thank you, Mr. Morrison. Mr. Buechner.

Mr. BUECHNER. Mr. Secretary, I happened to take a look at the budget that DOE had for this current proposed budget year and I notice that we are still paying part of the transportation costs of the Three Mile Island waste to Idaho Falls.

I think it is on page 109 of volume two. I don't know whether you have that with you or not. But we have a million dollars that we are still paying out of the cost. Is there a reason why we are picking up part of that tab and still the utility carrying the rest of it?

Secretary HERRINGTON. Yes, sir, if Mr. Vaughan could answer that for you, please.

Mr. VAUGHAN. That is an accounting thing. The money for the transportation of TMI-2 waste to our Idaho National Engineering Laboratory will eventually be reimbursed by the utility under an agreement that we have.

Mr. BUECHNER. So the Federal Government will not be underwriting any of that cost. That will be returned. Right?

Mr. VAUGHAN. For the transportation, yes.

Mr. BUECHNER. It is my understanding if you are familiar with that particular operation that a final site has been determined from Idaho Falls. Where is it going from Idaho Falls?

Mr. VAUGHAN. Well, ultimately it will go into the high-level waste repository.

Mr. BUECHNER. Can you tell me why we are moving all of it up to Idaho Falls to study the entire, I forgot how many tons of material it is?

Mr. VAUGHAN. First of all, it seems important, and there was a national consensus and agreement among many parties—utilities, the NRC, the Department of Energy— that it was best in returning the TMI site to a quiescent state—to get the fuel out of the reactor site and complete the placement of the damaged reactor in a stable condition where it would not in any way affect the environment.

Not all of the core debris being shipped to Idaho is being examined. Selective parts have been carefully taken from segments of the core for examination to help us understand the accident sequence and to obviously take actions to prevent that type of problem in the future.

Mr. BUECHNER. When you say that it is not all being studied, I guess my question is rather than move all of that material up to Idaho Falls and then move it ultimately to your disposal site which requires then two rather large transfers of this material, why the selection process wasn't done on site at Three Mile Island, removed only that and then take the remainder of the debris to the final resting site.

The reason I say this is because you run it through 180 yards from my house so I have a rather vested interest in it.

Mr. VAUGHAN. I didn't know it was that close to your house. [Laughter.]

Mr. BUECHNER. Some days it seems closer.

Mr. VAUGHAN. But I do know it goes through a segment of Missouri. It is a practical solution. I think if you lived in Pennsylvania near the Three Mile Island site, you would have the same view, that many of those people do, including their Congressmen, that they would like to get the fuel off that site.

Mr. BUECHNER. No. I understand that. That makes sense.

Mr. VAUGHAN. But examining it and temporarily storing it at Idaho NEL is simply a practical solution. Now with respect to the shipments, those shipments are being made in very carefully designed NRC licensed and certified casks. They have been tested for fire, been dropped from a train at 30-foot distances with no damage, and have had all sorts of safety precautions. I would remind you, that from a nuclear safety point of view, the fuel debris being removed from that core is relatively benign compared to other high-level waste shipments.

That reactor had operated a very short period of time and furthermore, what there is has been decaying for five or six years since then.

Mrs. LLOYD. Mr. Slaughter.

Mr. SLAUGHTER. Mr. Secretary, would you repeat what you said about the appropriation for the Mission Plan for the nuclear waste disposal sites? You said $725 million is in that program, and $500 million has previously been appropriated? Is that what you said?

Secretary HERRINGTON. $500 million is in our FY88 budget request that is before you. We will seek $725 to carry out the Mission Plan Amendment. The budget amendment is being worked on and will be sent up.

Mr. SLAUGHTER. Well, with a number of these sites, there are environmental considerations still to be considered and looked at, are there not?

Secretary HERRINGTON. Yes, sir.

Mr. SLAUGHTER. And also, questions of whether it is feasible or wise to locate these sites in places where the density of population is pretty heavy.

Secretary HERRINGTON. Yes, sir.

Mr. SLAUGHTER. Is there any research being done to find a method of destroying this nuclear waste rather than having to store it? We talk about so many years before we will actually be storing it. In the meantime, is there any research that ought to be undertaken along that line?

Secretary HERRINGTON. I think a lot of research has gone on. The current research is budgeted at about $25 million a year. That's one of the benefits I did not—it could be a benefit or it could not—that I did not mention. Delaying the decision on site-specific work for the second repository until 1995 or 96 does give you additional time to find additional methods of disposal, should they appear in new technology. I don't know what they would be at this point. But it is being researched not only in the United States but in France and other countries.

Deep geological burial seems to be the answer today that most of the scientific community agrees on.

Mr. SLAUGHTER. Thank you.

Mrs. LLOYD. Thank you very. Mr. Hall, I think you have three and a half minutes.

Mr. HALL. Thank you, Madam Chairman. Mr. Secretary, I of course want to thank you for your appearance here today and also thank you for the fact that on this side of the aisle, we have found you very available with your time, and as a matter of fact, this very day I think you were up before most of us briefing members on the budget and the study that is to be released today.

And down in my area we don't object to being targeted by some people who don't care about jobs and would let us boil our own water in behalf of the concho snake or some of those other ridiculous things.

I want to ask you about the cost-sharing with the private sector and technology transfers. I am not—are you talking about Space Station and SDI? Is that the type of technology transfer or sharing of cost that you're referring to here?

Secretary HERRINGTON. The cost sharing in the Clean Coal Technology Programs is where we have our most cost sharing. Our technology transfers I think run the gamut of everything we do in the national laboratories. We would like to encourage our technology transfer through our national laboratory activities and contractors there.

Mr. HALL. When you talk about technology transfer and sponsors, though, you are really talking about domestic sponsors.

Secretary HERRINGTON. Yes, sir.

Mr. HALL. And have you given some thought to international sponsors for the sharing of the costs for that transfer of technology, particularly on SDI inasmuch as the Administration has indicated that they're going to share that. And is there any legislation that is being prepared by your group or by the President's advisor on this committee—I forget his name.

Secretary **Herrington**. Yes. I could not answer on behalf of General Abrahamson. Our portion of SDI is only 10 percent; that portion that involves nuclear, so I could not comment on that. Certainly, with a project such as the SSC we are looking for cost sharing on a project that is estimated to cost $4.4 billion; we have substantial expression of interest from other countries such as Japan, France, and Italy on sharing in that particular project.

Mr. **Hall**. You have indicated that you are studying legislation, and I would ask you again if there's any legislation prepared or that's been sent over that would authorize the sale of some of our Federal interests in the Naval Petroleum Reserve. Particularly, I would ask you about the legislation authorizing the study of the feasibility of divesting the Southeastern Power Administration—where is that study and how far away is it?

Secretary **Herrington**. We are only studying the sale of the Naval Petroleum Reserves—I think June is the target for the study. Some of the Power Marketing Administrations we are unable to study by law, but we have requested Congressional authority to study the divestiture of the Southeastern Power Administration.

Mr. **Hall**. Thank you, Mr. Chairman.

Mrs. **Lloyd**. Mr. Smith? Or did you decide to swap time with Mr. Boehlert?

Mr. **Smith**. Yes, I'm going to yield to the gentleman from New York since he has an important engagement at 10:30.

Mr. **Boehlert**. Thank you, I do appreciate that. We have a markup going on down the hall starting three minutes ago.

Mr. Secretary, would you clarify for me on the record the Department's current position on a possible U.S.-Canadian joint venture on the SSC?

Secretary **Herrington**. I have heard nothing more than rumor. It is not our plan to joint venture that project with the Canadians. We are, in fact——

Mr. **Boehlert**. Are you ruling out? Because the rumor mill also has it that you're being negative in your reaction to a possible joint venture.

Secretary **Herrington**. I would think it is not a good idea. I am happy to say on the record that if the Canadian government would be happy to participate financially in the program and benefit from it, that would be fine. I have heard the rumor of the physical location on the border, owned half and half. We don't have any plans like that. We are going through a siting process now.

From the Canadians, like any other country, we would welcome some participation. It is an American project involving American high energy physics, and it is intended to maintain American leadership in this particular field. In my way of thinking, that is the way the project has been structured and I would recommend that it go forward on that basis.

Mr. **Boehlert**. So that you are negative in your reaction to any potential to joint venture.

Secretary **Herrington**. Yes, sir. If that means 50/50 ownership and funding, that would be my reaction.

Mr. **Boehlert**. Well, but I don't think we necessarily have to deal with 50/50 or 51/49, but just a possible joint venture with our long-time allies across the border in a very expensive proposition at a time when money is critically short.

Secretary **Herrington**. You know, I'm having trouble. I'm trying to be responsive but I don't know what joint venture means. Usually that means each side putting up half. We have expressions of extreme interest from the government of Japan. I don't know whether you would call that a joint venture or not.

Mr. **Boehlert**. A cooperative venture, then. I don't want to play with words but I'm saying are you ruling out any potential participation from other than a U.S.——

Secretary **Herrington**. No, no. I think Canadian participation, along with that of other countries, with the U.S. would be important. I would like to see the Canadians participate with us.

Mr. **Boehlert**. Doesn't that have a second part and it deals with an entirely different subject? You know, preparation is now underway for the third annual Shamrock Summit between President Reagan and Prime Minister Mulroney, and for the third consecutive time a topic of major consideration will be acid rain. Would you share with us the current Department position on the need for acid rain legislation to deal with the most serious environmental problem unattended in America today? That's a little editorializing, I admit. [Laughter.]

Secretary **Herrington**. I think the Administration position may be evolving on this issue. I would like to submit it for the record. We certainly are strongly supportive of the Joint Envoy Report; the President has endorsed it. We intend to abide by the recommendations in the report.

There is a substantial amount of money going into acid rain today. We are in negotiations with the Canadians on what projects count under the recommendations. I think our current budget, if you lump it all together in the Government, is about $1.7 billion. That's a pretty good commitment to acid rain.

[The information follows:]

Subject: The President's Fresh Look at Activities Implementing the Acid Rain Envoys' Recommendations.

The President on March 18, 1987, announced three initiatives to continue to carry out the recommendations of the Envoys for Acid Rain. These were:

Seek full funding ($2.5 billion) of the Government's share of funding for demonstration of innovative control technology over a 5-year period.

Direct the Secretary of Energy to establish an advisory panel concerning demonstration projects and to select projects using as fully as practicable, the criteria for project selection recommended by the Envoys.

Have the Vice President's Task Force on Regulatory Reform carry out a 6-month study to review Federal and State economic and regulatory programs to identify opportunities to address environmental concerns under existing laws.

Additionally, when speaking to the Canadian Parliament on April 6, the President stated: "The Prime Minister and I agreed to consider the Prime Minister's proposal for a bilateral accord on acid rain. . . ."

Mr. **Boehlert**. Mr. Secretary, it is my understanding that the issue is being "revisited in the White House" in preparation for the Shamrock Summit. Are you part of the revisitation team?

Secretary **Herrington**. How do you answer that?

Mr. **Boehlert**. With a yes or no. [Laughter.]

Secretary **Herrington**. The answer is yes.

Mr. **Boehlert**. That is good.

Secretary **Herrington**. I would rather not go into what is being discussed because I don't think that's fair to the President.

Mr. **Boehlert**. I understand that. But you are encouraging in what you are saying. I want to thank my colleague for yielding.

Mrs. **Lloyd**. One of our new members we are very proud of, Mr. Price from North Carolina.

Mr. **Price**. Thank you, Madam Chairman.

Secretary **Herrington**. Could I ask, where did you get the information? [Laughter.]

I mean, that's pretty current stuff.

Mr. **Boehlert**. Thank you very much; you're acknowledging that for the record.

Secretary **Herrington**. Let me compliment you on your sources.

Mr. **Price**. Mr. Herrington, I wonder if we could go back briefly to the question of the second high-level nuclear waste repository and the Mission Plan. The Mission Plan released in January of this year reiterates the Secretary of Energy's decision to postpone site-specific activities for the second repository. At the same time, it reiterates the ultimate commitment to a second repository; for instance, an intention to continue with the technical program for the second repository.

In your testimony today, you speak of a detailed budget supporting a $725 million program in this area of waste activity. Is it possible to specify what portion of that budget would go toward the non-site specific activities regarding the second repository, and to detail how that money would be spent?

Secretary **Herrington**. $24 million would be spent on research and development other than site-specific work. Identifying and evaluating methods, and technologies, and materials would be a good way of stating it, I think, in a general way.

Mr. **Price**. That $24 million is the long and short of it; there are no additional items anticipated in this $725 million regarding the second site?

Secretary **Herrington**. No, sir.

Mr. **Price**. You said a few moments ago that you would hope that Congress would give its endorsement to that Mission Plan, but would it be your view that in giving such endorsement, that Congress would be confirming its commitment to a second site?

Secretary **Herrington**. Yes. Our Draft Mission Plan Amendment says, in as clear language as we can, that we still are committed to a second site. It just says we don't want to do site-specific work now; it can wait until the 1996 timeframe. If Congress approves that Mission Plan Amendment it would be hard to interpret that as eliminating the current law on the second site requirement. It would say you don't have to go find the site right now, but you would still have the second site requirement hanging out there, I would think. I am trying to interpret what you are saying, but that's my general reaction.

Mr. **Price**. Now you, in the Mission Plan, stated that even the lowest current projections for spent fuel generation indicate that a second repository will be needed; yet your own recent testimony seems to suggest that we are nowhere near that 70,000 figure in our projection. Could you elaborate on that?

Secretary HERRINGTON. I think that is consistent. I think we are nowhere near those requirements within the timeframes indicated under the presumptions of the original law. I don't want to leave the impression that I don't think we will ever get there. I think if we order new plants this century, for instance, that we will reach the limit of 70,000 metric tons. I think that still is a valid figure. The question is when you get there.

Mr. PRICE. Well, with that degree of uncertainty, why is it that the Department retains this commitment for the second site and in fact projects these dates into the 1990's when that site selection process will go forward?

Secretary HERRINGTON. Well, the reason we maintain the need for a second site is that we are legally obligated to. The law is very clear that we are to find a second site; what the law is not clear on is, in my estimation, whether it is authorized, just in the law, or appropriated for. I think there are a lot of questions open in that particular area. The law says you shall find a second site by a certain date, and you will find a first repository by a certain date.

I don't think we have the legal authority to walk away from a second site. I think we do have the legal authority to suggest to Congress in the Mission Plan Amendment some modifications as to how we go about it, and that is what I think we have done. I am finding tremendous disagreement with that position. We are being sued in many courts; we have a number of Congressmen saying that we have walked away from the law. Yesterday an editorial in the New York Times said that we have violated the law. That is not our intention. I am trying to be a good manager of the program.

I put it before Congress again. If Congress says, we don't want to deal with it, or, you are doing it wrong, and doesn't endorse what we are doing, I have to go back to what the law says because I think that is my job, to carry out the law, and start work again on the second repository. I don't know how else to explain it to you, but that's the way I look at the job.

Mr. PRICE. Thank you, Madam Chairman.

Mrs. LLOYD. Thank you. Mr. Smith of New Hampshire.

Mr. SMITH of New Hampshire. Thank you, Madam Chairman. Just continuing along the same vein as my colleague from North Carolina, just to reiterate Mr. Secretary, out of the $725 million, the only monies that are targeted for site specific work on a second repository is $24 million dollars. Is that what you said?

Secretary HERRINGTON. Yes, sir. Actually, that is not for site specific work. There is zero targeted for site specific work in the $725 million. There is $24 million targeted for a second repository but only in general terms not dealing with North Carolina or any other state.

Mr. SMITH of New Hampshire. In terms of the direction, let's use the word, direction of Congress regarding the law and Congress writes the law not always with great wisdom but they do write laws. If Congress were to strike that money, what would be the reaction of your Department? If they were to strike the $24 million or any amount of money that was placed in your budget for site specific work on a second repository, how would you interpret that?

Secretary HERRINGTON. I have no idea. We are not proposing any money for site specific work. There is nothing to strike. The $24 million will be for research and development on a second repository. We would obviously not be able to conduct that research and development.

I have said this before and it has been my intent ever since May, if Congress doesn't act affirmatively the law will require us to find that second site and if the Congress doesn't act affirmatively to approve that Mission Plan Amendment, I don't think I can proceed on the Mission Plan Amendment without that kind of endorsement.

Mr. SMITH of New Hampshire. One of the concerns I have about the Mission Plan is, does it really go far enough into the future. By your own testimony earlier today, you said that you don't know if we need a second repository and I think that is being honest. I don't think anybody really does.

The cap on the western site, the 70,000 metric ton cap, was at best arbitrary. We know the politics of the situation, east versus west and all of that.

But if we don't know whether we need it and we admittedly realize that we are no where near the 70,000 ton cap which is at best arbitrary to begin with and many estimate that we could bury double that and not have a problem in one of those sites or in that site, wherever it may be in the west, why stir up so much controversy at this point without more long-term studies in terms of what might be the best site?

I realize you are dealing with the law but at the same time, you have it in your power and scope to make recommendations to us in terms of what we ought to be doing and how we ought to be doing it. If there is a better site somewhere else or a better method somewhere else in the future, why not look at that before saying arbitrarily that we are going to go back to site specific work in 1995 in whatever those six or seven sites are in the eastern part of the United States?

Secretary HERRINGTON. I don't think I have that luxury. I would be happy to make all of the recommendations you want but the law is quite specific on my obligations as Secretary of Energy to find a second site and that requires site specific work.

I have made a recommendation in the Mission Plan Amendment that we go about it in a different way and it has been obviously very controversial. I think it is the best way to manage the program, but as Secretary of Energy, I don't have the luxury of walking away from the law.

I am going to carry out this program as Congress directs. The job of making the law, or making the decision whether you need one site or two sites, and how it is determined rests with Congress.

Mr. SMITH of New Hampshire. One more question, Madam Chairman. Am I correct that when and if site specific work begins again say in 1995 if your Mission Plan is adopted, that it would be the same sites that are now identified as a second site?

Secretary HERRINGTON. That question has been asked. It is hard to answer because you don't know what will have changed in that time or if we have new technology.

My feeling is that you would go back and start over. The information that we have today on those sites will be put on the shelf—and we have gotten a lot of new information since we started the process—but you are not so far down the line that you want to be married to that information.

I think you want to go back and look again at all of the sites. For instance, if we find in building the site in the west that a certain rock formation is better than a certain other rock formation or if the technology for going through a water aquifer needs modification, all those things come into play in site selection in the east.

That is one of the benefits of putting off your decision on an eastern site as to site specific work.

Mr. SMITH of New Hampshire. So you don't feel that we are locked into any specific site or sites that have been identified at this time?

Secretary HERRINGTON. In the east?

Mr. SMITH of New Hampshire. Yes.

Secretary HERRINGTON. No. I think you are locked into the sites that have been identified in the west until such time as we finish characterizing them and you find out whether they are good or bad. They represent the best sites the technical community can help us identify today in this country, and I don't see anything better.

So in the west, I think you are locked into characterizing three sites and if those three don't make it, go to the other two of the five that have been identified.

In the east, I would say that you are not locked in. We certainly have indications of the direction you ought to go.

Mrs. LLOYD. Mr. Smith from Texas.

Mr. SMITH of Texas. Mr. Secretary, just last November the Energy Research Advisory Board recommended that DOE reorder its budget priorities to give oil and gas top priority in light of their overall dominant role in energy usage in this country.

The Board recommends an initial increase of $50 million dollars primarily to fund six research centers in oil and gas producing regions. How do you respond to the reordering of priorities recommended by ERAB and are you prepared to support the establishment of the six research centers this year?

Secretary HERRINGTON. Who have you been talking to on ERAB?

Mr. SMITH of Texas. I am reading the report right here.

Secretary HERRINGTON. First of all, I think the ERAB report is excellent and I personally support more R&D money for enhanced oil recovery. As we lose production, I see an opportunity to probably get more return on the enhanced research and development.

I don't want that comment to indicate that I totally endorse everything that report says because I would like it to go through the staffing process of the Department. The report is fairly new and I want to work it into our budget process; and I don't want to preempt that.

ERAB is an advisory board only and I think that is the function I would like to keep them in.

Mr. SMITH of Texas. Let me follow up then and ask you this. Are you going to encourage enhanced oil recovery?

Secretary HERRINGTON. Yes.

Mr. Smith of Texas. Is that going to move up the list in your list of priorities?

Secretary Herrington. I think it is very important.

Mr. Smith of Texas. Well, I know it is important but what I am asking for is are you going to increase its priority and are you inclined to spend more rather than less for enhanced oil recovery?

Secretary Herrington. Without giving the Assistant Secretaries a chance to argue over competing funds and priorities in the budget process—I don't want to preempt that process. I don't think that is fair as a manager.

It certainly has moved up on my list of priorities overall, especially with the security study coming out that shows that we can get a better return on enhanced oil recoveries. The method by which we do that and whether we do increase the budget, how we do it within the structure of the Department of Energy, is important to me.

Mr. Smith of Texas. Would you personally favor spending $50 million for the research centers?

Secretary Herrington. I simply can't answer that. I would have to look at where they are going, how they will be used, and how they fit into the total plan.

Mr. Smith of Texas. But you are not opposed to it at least?

Secretary Herrington. No, sir.

Mr. Smith of Texas. All right. Let me ask you one brief question going to the SSC. Do you foresee in the invitation for proposals limiting States to one proposal each?

Secretary Herrington. No.

Mr. Smith of Texas. All right. Thank you.

Secretary Herrington. Do you mean one location or one proposal?

Mr. Smith of Texas. One location is what I am trying to say.

Secretary Herrington. No.

Mr. Smith of Texas. In other words a State could submit a proposal that would include two possible sites?

Secretary Herrington. I think many intend to. I think it is important that we get the right site.

Mr. Smith of Texas. And not just limit it.

Secretary Herrington. Yes.

Mr. Smith of Texas. All right. Good. Thank you.

Mrs. Lloyd. Thank you, Mr. Smith. The Chair now recognizes my neighbor, Mr. Walker.

Mr. Walker. Thank you, Madam Chairman. Since 1984, there has been about $150 million given to the Department of Energy for university construction projects for research that is neither merit-based nor peer-review process-based.

I would like to know what the Department's position is with regard to Congress allocating money for non-peer review research.

Secretary Herrington. I think we put those projects in a rescission, sent them to the Hill, and the rescissions were not acted on. So I think the projects are back in our budget two years in a row.

Mr. Walker. The fact is though that Congress has not been acting on those rescissions so the money has been going forward and I assume that therefore the universities have been the beneficiaries of all of that money.

Does the Department intend to aggressively oppose any such projects for inclusion in the fiscal year 1988 authorization or appropriation processes?

Secretary HERRINGTON. Mr. Walker, we are opposed to them. I don't know how much more aggressive we can be.

Mr. WALKER. Well, for example, last year when we were fighting the battle here and on the Floor, we couldn't even get a letter out of the Department saying that you were opposed to it.

Secretary HERRINGTON. This year, we will give you a letter. I didn't realize last year that you could not get a letter. It never came to my attention. I would have been happy to give you a letter on it.

Mr. WALKER. Thank you.

Secretary HERRINGTON. I don't think it is a good idea. Miss Schneider asked a minute ago about our budget going down in conservation and renewables. A lot of that was exactly what you are talking about, sending rescissions back up. We tried to take those projects out. That is why the budget is done.

Mr. WALKER. I think it is useful to do it in the rescission process. The problem is, as I say, around here the rescission process doesn't work very well. What would be helpful is if we could launch a battle in the first place to assure that all of the research that we are getting is, in fact, merit-based or peer review-based and what I am suggesting is that it would be helpful to some of us who are fighting those fights often against committee chairmen to have the support of the Department in that.

There are a lot of folks who seem to think that once you get into positions of power around the Congress, getting a few goodies for the folks back home is just part of the process. The fact is that that is robbing our research budgets when we do it that way and it would be helpful to have you aggressively involved in opposing those kinds of projects.

Secretary HERRINGTON. I think your point is very well taken. They do rob our research funds and it is not just the ones that you mentioned. It is not limited to just those particular projects. So I heartily endorse what you are saying.

Mr. WALKER. I thank you. Thank you, Madam Chairman.

Mrs. LLOYD. Thank you very much, Mr. Walker. Mrs. Morella?

Mrs. MORELLA. Secretary Herrington, good to see you here. I am sorry I missed the early part of the discussion so you may well have already commented on the Superconducting Super Collider. And I would like to know very much about what the plans are for looking for a site and just how you see that proceeding, and what part of the budget it is going to have and whether there should be some concern about that usurping some of the monies that might well have been used for other energy R&D projects.

Secretary HERRINGTON. Most of the States that have an interest in this project have been following it for three years, so they are pretty much up on it. We have been spending about $20 million a year on research and development. We announced February 10th that the criteria for a site will be out in April. That has been received pretty well by the States.

The criteria are pretty simple, so it will be easy to put together a proposal. We hope to have those proposals by the beginning of

August. We would refer them to the National Academies of Sciences and Engineering which has set up a committee to review those proposals and make recommendations to us. Hopefully, on our tentative schedule a preferred-site selection could be made in July 1988 and then environmental work and site-specific work could continue to January 1989 when we would make a final site selection.

That is the current schedule. It seems to be one that everybody likes, with project completion in 1996. It is our feeling that with the increase in the National Science Foundation budget, a doubling, even a tripling since 1980, that the other scientific disciplines will be taken care of. It looks like a pretty good scientific program across the board that the Federal Government is working on.

Mrs. **MORELLA**. You mentioned April. Is it going to be early in April?

Secretary **HERRINGTON**. Yes.

Mrs. **MORELLA**. Early in April you are going to get the site proposal.

Secretary **HERRINGTON**. Early in April we will request proposals, the criteria will be made known at that time. They are things like electric power site requirements, how you provide the land; basic things.

Mrs. **MORELLA**. You are going to have a panel, also, for it. How are you going to choose it? Have you looked ahead that far? It seemed like——

Secretary **HERRINGTON**. I think the principal panel is being chosen by the National Academies of Sciences and Engineering, and they will take the best experts we have to look at it. I don't know who is on the panel and I don't have a sign-off on the names. We have asked them to give us their best advice.

The panel in the Department of Energy will obviously look at it. I think we will probably use the same type of panel that makes our other site selections or a procurement-type panel at a lower level. But the best professionals we have. I don't pick any of this.

Mrs. **MORELLA**. Have you received any opposition on the whole concept of the Super Collider?

Secretary **HERRINGTON**. No. We have had a lot of questions but no opposition. Everybody that I have talked to thinks it is a project that this country should do, and it's important to our leadership in high energy physics and that the commercial spinoffs from it will be substantial.

Mrs. **MORELLA**. Thank you. Thank you, Madam Chairman.

Mrs. **LLOYD**. Thank you very much, Mrs. Morella. I want us to all go around again. I think that we are on a pretty good time schedule, and Mr. Secretary, there will be some questions that we will not get to, obviously, but I would request that you answer questions we will submit to you in writing that will be made a part of the record of this hearing today.

I want to go back to the MRS. We discussed earlier that it is more cost-effective not to have an MRS in the program, but you stated that well, the major concern was not money, the major concern was safety.

I am missing something, Mr. Secretary. Does DOE consider it unsafe to transport spent fuel?

Secretary HERRINGTON. No. You know, I said that other considerations that should be weighed more than cost—I don't know if I'm changing what I said, but I will concentrate more carefully on this. The cost is not the number one factor; there are other considerations such as environment, such as safety, and I think if we want to get to the MRS specifically—because the cost factor is one that has come up in Hanford a lot. Hanford is not the cheapest site under cost-ranking, and yet if you take away cost, it is the best site.

Mrs. LLOYD. Well, do you consider it unsafe to transport spent fuel?

Secretary HERRINGTON. No.

Mrs. LLOYD. Well, a system that relies directly on shipping from the power plants to the repository would not be unsafe or unduly risky, would it?

Secretary HERRINGTON. No, but it wouldn't be as efficient as an MRS where you can bring the fuel in, package it correctly and control your shipments, rather than have individual shipments from every reactor on the East Coast moving towards the permanent site.

Mrs. LLOYD. But it would be less expensive and it would be safe as well to opt for an at-reactor storage instead of an MRS.

Secretary HERRINGTON. I'm not sure of the cost. Certainly, building the MRS is expensive. Whether moving it to the MRS and then moving to the site on an operational basis is cheaper, I don't know. I would be happy to submit that for the record.

Mrs. LLOYD. You do not know whether it is less expensive.

Secretary HERRINGTON. If you take out the cost of the MRS and consider just the cost of transportation, shipping from a reactor to the disposal site or shipping to an MRS and then to the reactor site, I don't know which is more cost-effective for long-term operation.

Mrs. LLOYD. It seems to me from all the evidence that it would be more cost-effective to have on-site storage. But safety—we do not have a safety consideration from reactor site to the permanent disposal facility; is that correct?

Secretary HERRINGTON. I don't think you have a safety problem. You would have a definite transportation network problem and you have a public confidence problem because there's tremendous objection to——

Mrs. LLOYD. But it is safe and probably less expensive. Well, of course, one of the major criticisms which you are well aware of, we are having objections today to the second repository sites, the eastern sites, and I think it is worth remembering in this hearing today that we would never have gotten this nuclear waste policy bill passed if it were not for the inclusion of the second repository site in the East. This was part of the conditions.

I think that the feeling is that once an MRS is built, that the political controversy over the repository will make it impossible to move ahead with this. This is a feeling of the people that I represent in the state of Tennessee. And I know that you are personally not to blame; I don't blame you for this, but you know, the Federal Government just really doesn't have a good record in keeping promises with the people in my district or the people in other parts of the country, from one Secretary of Energy to the next.

If you remember, Secretary Hodel promised me and the people of Oak Ridge that the gaseous diffusion plant would be left open for three or four years in transition and that we would continue with our centrifuge program. And then I met with you and it was closed down in a period of months. And we had the fiasco over Clinch River.

So really, the people in my district have a feeling that the Department of Energy cannot at all times be relied on for their future. I think this is a real tragedy and I don't think there's any real basis to feel that they can have any assurance that once an MRS should be put in that area that it would not indeed be made a permanent repository.

This is a real fear, and I want to ask you if you really felt that some future administration would halt and cut back on the MRS construction if there were a delay in the repository schedule.

Secretary HERRINGTON. I really don't know.

Mrs. LLOYD. You don't know?

Secretary HERRINGTON. I really don't.

Mrs. LLOYD. And yet we are being asked to mortgage the future of our area; a community that has done so much not only for our national security but in our pursuit of excellence in scientific programs, to take on this responsibility. Mr. Secretary, you have asked a lot.

Miss Schneider.

Miss SCHNEIDER. Thank you, Madam Chairwoman. Mr. Secretary, sometime ago, the General Accounting Office had made two specific recommendations to you. One of them was for DOE to allow for outside independent reviews of your safety analysis reports for DOE facilities, and the second recommendation was the need for outside independent inspections of the disposal practices used for any waste that self-regulates.

I am wondering why you have not picked up on those two recommendations on the part of GAO, seeing as how they made a pretty substantial case in support of those suggestions.

Secretary HERRINGTON. I would have to know what facilities you are talking about. We did appoint the Roddis Panel, a group of independent consultants. We have referred all of our facilities, top to bottom, to the National Academy of Sciences and to the National Academy of Engineering, and a current review is ongoing at this point, and that is certainly an independent group.

I am interested in proper operation of our facilities as much as anybody. The Assistant Secretary for Health, Safety and Environment has the authority to shut down our facilities. I think we are doing a pretty good job, Ms. Schneider, on that particular area.

If there is some area specifically that we are missing, I would like to hear about it.

Miss SCHNEIDER. Well, those evidently are outlined in a subsequent General Accounting Office report that was made to the Senate just recently, as a matter of fact, and they have also sent you a letter where they recommend development of a strategic plan that would be a valuable tool for Congress in making effective legislative and budgetary decisions. They itemize four different recommendations to provide for the cost, timeframes and safety considerations.

I wonder if you have given some thought to that GAO series of recommendations and if you have some plans for implementation.

Secretary **HERRINGTON**. Well, my understanding is that it is dated March 12th. Are we referring to the same one?

Miss **SCHNEIDER**. Yes.

Secretary **HERRINGTON**. So it needs to have a little review. I have seen it and I have it in front of me, but I am not prepared to comment on it yet. It certainly should get some review and some consideration.

Miss **SCHNEIDER**. Well, I would very much appreciate it if you could direct your response to me and to the record as to which of these proposals you intend to implement, if any, and what your time schedule is, please.

Secretary **HERRINGTON**. I would be pleased to do that.

[The information follows:]

> The Department is in the process of reviewing and preparing a response to the March 12, 1987 General Accounting Office testimony report, T-RCED-87, "Environmental, Safety and Health Aspects of the Department of Energy's Nuclear Defense Complex." We would be happy to provide a copy of the response to the committee when it is completed. The statutory due date is May 12, 1987.

Miss **SCHNEIDER**. Okay, thank you very kindly. I have no further questions.

Mrs. **LLOYD**. Thank you very much, Miss Schneider. Mr. Bruce.

Mr. **BRUCE**. Thank you very much. Just following what the Chairwoman has just commented about, long-term endorsements and continuing a policy that continues from one Secretary to the other.

Last January, the President agreed to support the SSC. In what tangible way does the President's support affect this project and does the Administration possess a long-term commitment to the SSC and, if so, how do you illustrate this commitment to the Congress and to the Nation as a whole?

Secretary **HERRINGTON**. I don't know what a President could do other than publicly embrace the project as important to the future of the country and then put sufficient money in the budget to carry it out. I think the ball then transfers to the court of Congress.

I guarantee you that through my meetings with the President, that he is fully on board with this project, and I do so publicly. I don't know what else we can do.

We are putting $35 million in 1988 and we will obviously in 1989 start with the heavier funding.

Mr. **BRUCE**. In your statement you indicated $35 million dollars in the coming 1988 fiscal year budget and a total cost of $4.4 billion in 1988 dollars. I wonder, I am a strong supporter of the construction of the SSC, but I also listened very closely to the concerns of the Chairman and her problems that she has had in her area and other colleagues have expressed the concern they have of such a large project and its effect on the overall research capability of this country and research dollars going into the scientific community.

What is the impact going to be of the SSC on other science to be done and other research projects in the Department?

Secretary **Herrington**. My feeling is very little. We are asking for new money for SSC. The National Science Foundation budget is independent of the SSC proposal and it, of course, is being doubled and tripled for other science projects.

If the SSC is built by 1996 and if it goes into operation, you will see an operating impact on other Department of Energy high energy physics-type projects because we will be budgeting, I think, about $270 million per year for operation of SSC. I think some of the other projects that are a little older will begin to be cut a little bit.

I think it would be a serious mistake to correlate SSC with the projects the Chairman was talking about, the centrifuge and the gas diffusion uranium enrichment. They are apples and oranges.

SSC is a basic research high energy physics project with international prestige. It has the potential of returning probably one of every three commercial dollars to the treasury, through economic activity. It is a whole different type project.

Mr. **Bruce**. I think Mrs. Lloyd's question went really not to the specific project but the commitment. Twice in your testimony and in answer to my question you said, "If we decide to do it" and "If we build it then we would have $250 million annual operating costs."

My question is, what does the "if" apply to, if Congress or if the Department of Energy continues to support the project?

Secretary **Herrington**. No. We will continue to support it but this is a joint effort between the executive branch and the legislative branch. At this point the ball is in the legislative branch court. We are fully supportive of it.

We don't have a clear signal from Congress yet whether Congress will go along. My feeling is that they will, but that is not an iron-clad situation yet, obviously.

Mr. **Bruce**. Finally, Mr. Secretary, in the construction and development of the SSC, have you implemented any new scientific R&D projects, any cost-effectiveness procedures that will be implemented particularly in the site selection of the SSC?

Secretary **Herrington**. I don't think there is anything new. One of the advantages of SSC is that the technology to build it is pretty much known, so you can get a handle on your costs. In other words, the superconducting magnets are known technology and the research has brought those forward.

You are not looking at any radical high-tech developments to build it. You pretty much know what you are dealing with. What you get out of it is unknown.

There is a 19-percent cost contingency built into the figures, building with known technology. That is why I think you can with assurance predict the cost at the $4.4 billion level.

Mr. **Bruce**. Thank you, Madam Chairman. I would like to be able to submit a statement into the record at this point.

Mrs. **Lloyd**. Without objection, your statement will be made a part of the record.

[The prepared statements of Mr. Bruce and Mr. Fawell follow:]

STATEMENT OF TERRY L. BRUCE

Mr. Chairman, I would like to thank Secretary Herrington for appearing before this committee this morning. As a member of this committee's Energy Research and Development Subcommittee and, as a member of the Energy and Power Subcommittee of the Energy and Commerce Committee, I look forward to the Secretary's testimony regarding the policy implications of civilian energy research and development and related programs included in the DOE budget for fiscal year 1988.

I am particularly interested in giving Secretary Herrington the opportunity to discuss the DOE's exciting new project, the Superconducting Super Collider, or the SSC. The SSC, of course, was approved by President Reagan last January and has been included in the DOE FY '88 budget for the amount of $35 million.

As my colleagues are aware, the initial mark-ups on the DOE budget, scheduled by the Energy R&D Subcommittee for next week, will not include the SSC. Still, I think it is especially appropriate for Secretary Herrington to discuss the SSC before this committee today and to address particularly the concerns of Energy R&D Subcommittee members who will meet again after next week to mark up the DOE budget with the SSC. I understand those concerns to be specifically: the level of the Administration's commitment to the SSC; and the policy implications that funding this project would have for other energy projects and programs.

For myself, I am convinced that broad bipartisan support already exists in Congress for the Super Collider. In fact, I hosted two special orders in the past two weeks on this subject. Overall, almost 50 members from 17 States went on record in support of the SSC, including House Minority Leader Robert Michel, House Majority Whip Tony Coehlo, and the ranking member of this committee, Manuel Lujan. As a friend, and vice-chair of the Republican conference, Lynn Martin said in support of the SSC: "The world doesn't stand still; if we accept the challenge, we move ahead. If we reject it, other nations move ahead without us." I hope we on this committee move ahead by authorizing the SSC.

Like any basic research project, the scientific goal of the SSC is to acquire knowledge. Still, there are many examples of basic research that has lead to profound innovation. In fact, most of today's technology is based on fundamental discoveries of the 19th and early 20th centuries. So, while it's difficult to predict the impact of future generations of discoveries made at the SSC, if they're anything like the previous discoveries, the rewards will far outweigh all investments.

And should the SSC be built in another country, Mr. Chairman, we, in this country should not be surprised to watch the world's preeminent scientists set sail for Europe or Japan. We should not be surprised that we lose our vital national resource—our scientific researchers.

Secretary Herrington, I welcome you here this morning and I look forward to discussing with you this important project, the SSC. Thank you, Mr. Chairman.

STATEMENT OF HARRIS W. FAWELL

Mr. Chairman, I am very concerned about the continued decline in the budget for civilian research and development in the Department of Energy. Over the last six years the budget for civilian energy research has fallen by 50%, from $4.1 billion in FY80 to only $2.2 billion in FY86. These cuts endanger the integrity of our civilian energy programs and will in the long run threaten the security of our nation's energy future.

These cuts become even more disturbing in the face of increasing budgets for military research inside DOE. Only seven years ago, military programs accounted for only 38% of DOE's total budget; civilian energy research accounted for 57% of the total. In FY 88, these figures will be reversed. Military programs will account for 58% of DOE's budget, while civilian research will account for only 37%. Over half of the $8 billion for military activities are for weapons research, production, and testing. Obviously these activities have few spin-offs and little positive impact on civilian programs. Possible spin-offs from other military programs are also doubtful. The trend toward increasing militarization of DOE's budget poses as great a threat to the civilian research budget as do direct budget cuts.

This trend can be seen within the budget for advanced reactor research. The Administration acknowledges that our energy future will require the development of advanced reactor systems. Advanced generations of civilian nuclear systems still represent the most practical long-term hope for plentiful electrical energy supplies. However, the advanced reactor budget is again targeted for cuts, from $75.5 million in FY 87 to $70.7 million in FY 88. In the past two years, advanced reactor research has been cut by almost 50%! But of the four major program areas in DOE's fission research—advanced nuclear systems, space and defense power systems, advanced reactor R&D, and light water reactors—only the first two areas are targeted for increases. Not ironically, these two areas most directly serve the military. The proposed $48.3 million increase in FY 88 for space and defense power systems alone could almost restore two years worth of cuts in advanced reactor R&D.

This is not a tolerable strategy for the future well-being of our nation, either domestically or internationally. Given the growing importance of civilian nuclear worldwide, and the inevitability of its widespread use internationally in the future, the U.S. must try to lead and shape this future in ways that both aid the efforts of other nations to achieve the energy security they are seeking and to discourage the misuse of the technology for military purposes. The way to do this is through research into advanced reactor designs, which will promise superiority in both regards. In addition, we need to continue an active international effort encouraging worldwide adoption of responsible civilian nuclear systems and norms. The U.S. can play a responsible role as both a partner and a leader in this effort.

The way *not* to promote our domestic and international energy interests is through disregard of civilian nuclear development and increasing militarization of DOE. This would drop a four-decade commitment to the development of safe, responsible civilian nuclear power. But this is what the DOE budget proposes. We must reverse this direction. Civilian energy research has been cut more deeply than a prudent energy policy would allow. I would like to see a reprogramming of funds from military research within DOE toward civilian research. This action would demonstrate our commitment to a safe and responsible energy future for our nation.

Mrs. LLOYD. Mrs. Morella.

Mrs. MORELLA. Thank you, Madam Chairman. I was reading over your testimony, Mr. Secretary, and I notice there is a comment on the Strategic Petroleum Reserve, something that has always interested me and the recommendation through the budget is to reduce the fill rate from the present 75,000 barrels per day to 35,000 barrels per day.

Wasn't that 75,000 barrels per day reduced early on? Wasn't it even originally anticipated to be more than that and that that, in fact, is a reduction and this would be a further reduction?

Secretary HERRINGTON. It has been more historically. The fact is today that we have filled that part of it which you could fill at a higher rate. Our maximum fill rate today, physically constrained by pipe capacity, is about 100,000 barrels per day.

Congress gave us 75,000 last year and we filled at 75,000. The recommendation to fill at 35,000 is strictly budgetary. It is not driven by energy recommendations or energy policy.

Mrs. MORELLA. That is what is so peculiar because here we get signs and statements that we have to be very careful about being overly dependent and how it relates to national security while at the same time we condone a reduction of the amount of the fill.

How do you personally feel about that? Do you think that is wise in terms of trying to be cost effective or kind of frivolous?

Secretary HERRINGTON. I am caught between my personal feeling as an Energy Secretary and carrying out an Administration position based on the total Government budget. So I have to divorce my personal feeling on it.

We have to argue within the budgetary process of the Executive Branch.

All things being equal, the best energy policy would be a maximum fill rate. It is the best protection we have for our long-term energy security, but as part of an Administration effort to reduce the deficit and meet Gramm-Rudman targets, which are very difficult, I think 35,000 barrels per day is a reasonable fill rate.

Mrs. Morella. How much do we save by reducing the fill per year?

Secretary Herrington. It is better stated: How much do we gain by filling at 75,000 versus 35,000? It makes more sense to me. You gain four and a half days supply through a higher fill rate and you spend about $225 million dollars. So to me, it is a toss up. It depends on how you view the crisis situation or the emergency situation, whether you can afford to back off a little at this point. It is a judgment call.

Mrs. Morella. It just kind of surprises me. Thank you, Mr. Secretary. Thank you, Madam Chairman.

Mrs. Lloyd. Thank you very much, Mrs. Morella. Mrs. Morella is also one of our newer members that has taken an active part in our hearings and I want you to know that we are very proud to have you as a member of this committee and we look forward to hearing from Mr. Price again.

Mr. Price. Thank you, Madam Chairman. Mr. Secretary, could we return to the SSC project for just a moment. In response to a previous question, you laid out a timetable that calls for the proposals to be in by August and anticipated NAS recommendation by January of 1988. Is that correct?

Secretary Herrington. Yes, sir, that is the current plan.

Mr. Price. I wonder if you could give us the rationale for that timetable particularly given the fact that a number of the areas interested in this facility have indicated that it presses them severely?

Secretary Herrington. I haven't heard that.

Mr. Price. You haven't heard that?

Secretary Herrington. I have not heard that. I have heard from States that have been following this——

Mrs. Lloyd. Will the gentleman yield?

Mr. Price. Yes.

Mrs. Lloyd. As the Secretary has not heard it, then he will be hearing very much about it.

Secretary Herrington. I have heard the contrary from many States which have been following this very closely for three years, and who are very much up on it. They think the timetable is very reasonable. It is what I think is a reasonable timetable. I would be happy to hear otherwise, but that is the best answer that I have.

Mr. Price. How was this set of deadlines arrived at?

Secretary Herrington. In cooperation with the National Academies of Sciences and Engineering, talking to them about how long it would take them to review the proposals. The plan is that when the proposals come in, there will be a first cut at the Department of Energy.

In other words, we will try to eliminate ones that do not meet the qualification criteria, which I must say are very simple criteria, and give every one that meets the criteria to the National Academy.

They winnow it down to what they think are the serious sites. We are not saying, "Give us two, give us three, give us ten." We are saying, "Give us the best sites" and then the Department will make another cut when they come back.

To my way of thinking and through our procurement process, it looks like that is a reasonable schedule. It may prove not to be a reasonable schedule, but as of today, it seems to fit everybody who is interested.

Mr. PRICE. To what extent have you set these deadlines in consultation with interested States? To what extent have you inquired as to the amount of time that is needed to develop a full proposal?

Secretary HERRINGTON. I guess I get ten calls a week from interested States and certainly when I go to a State, people are trying to pay calls. I get a lot of input. So does our energy research area. So does our scientific advisor. So does the White House. So does Congress.

It is a very hot topic right now. I think our input is excellent. Nothing is set in concrete obviously, but we announced our schedule February 10th. I would be interested in the views of the gentleman on your right from Illinois. His State is a contender for this. What does he think of the schedule?

Mr. PRICE. Well. I am asking you how the deadlines were set and what flexibility you have in accommodating all the States that might make the proposals.

Secretary HERRINGTON. I have flexibility. We are not trying to foreclose the process. That is important. I want the process to be open and for us as a country to get the best site. That is my agenda.

Mr. PRICE. What kind of flexibility do you think you might have? How much would your plan be hurt by a reasonable delay?

Secretary HERRINGTON. My feeling is that our plan is reasonable and we are going to adhere to it until we have a good reason not to. I have no reason at this point. I don't know whether that is flexible or not but the way I am heading, I think is the right way. Nobody said it isn't so far.

Mr. PRICE. So there is no particular reason though for August as some kind of date that is set in concrete.

Secretary HERRINGTON. No, but it helps us meet 1996.

Mr. PRICE. My time has expired. Thank you.

Mrs. LLOYD. Is there any other question you would like to pursue at this time from either Mr. Bruce or Mr. Price?

Mr. BRUCE. Madam Chairman, I just wanted to follow up on that timetable. In fact, I, like members from the States of California and Texas and others are concerned about any slippage. Also, there ought to be expressed some desire to keep this program on schedule. The Chairman here has indicated the problems——

Mrs. LLOYD. Will the gentleman yield? If this program is on schedule, it will be the first program that has been on schedule.

Mr. BRUCE. Let's break the mold then and put one on schedule. My concern is that as expressed by the Secretary if we want to make a 1996 deadline, we have to keep moving on. I don't want to preclude any state from making a proposal. I don't believe the Secretary does either but I also believe that Illinois, quite honestly, has watched this project for more than three years quite closely.

We have not been unaware of its coming down the track and have not been unaware of the need to be prepared. I think Illinois has prepared and is ready to move for the August deadline.

I guess my concern is that other States have not been as forward looking and now would like to change the rules a little bit of the game. August is comfortable for Illinois. I also realize that this is a collegial body and we will make whatever adaptations necessary to get the SSC sited and built, but I do think that the Secretary's comments about making the 1996 deadline ought not to go unnoticed.

If we want to remain competitive in the world, particularly in the area of high energy physics, we are going to have to keep on some schedule whether it be August or September or October. We have to stay on some schedule.

Mrs. LLOYD. Thank you. Is there further comment?

[No response.]

Mrs. LLOYD. My thanks to both of you. I have a couple more questions I would like to follow up on, Mr. Secretary, and you have been most generous with your time this morning. We are very appreciative. I would like to go back to the funding for the HTGR in this budget in contrast to the LWR budget.

It seems to me that this is about one-seventh for HTGR compared to what you have requested for the LWR R&D. What is the real basis for requesting only five million dollars for the HTGR?

It seems to me that this is the most promising design we have, not to take away from HTGR, to really prime the public's acceptance and to really make movement in our nuclear programs.

It is really hard for me to understand because $45 million for LWR's is really not consistent with your policy that you stated of a Federal support for near-term, low-risk projects.

I would like for you to respond to that please. I am puzzled.

Secretary HERRINGTON. The decision is primarily budgetary, but I would like Mr. Vaughan to address that question.

Mr. VAUGHAN. Mrs. Lloyd, as you know, there are differing views on what is the best approach for near-term and long-term solutions. We have tried to listen to those views. We had an Energy Research Advisory Board panel look at those.

Mrs. LLOYD. Excuse me. Isn't this a near-term?

Mr. VAUGHAN. The general view, endorsed by the ERAB group, is that the nearest-term solution to reviving the nuclear option in this country is through advanced light-water reactors as a practical choice, and every utility executive I have talked to gives me essentially the same answer. That is the reason why we believe a program aimed at advanced light-water reactors which can be certified and licensed by the NRC, available for order in the early nineties, and which does not require a demonstration plant, is the best path to near-term restoration.

I would remind you also that in the dollar figures you quoted, that $8 million of the light-water reactor budget completes our commitment for TMI R&D cleanup efforts.

Mrs. LLOYD. I am aware of that, but it seems that this is still a——

Mr. VAUGHAN. I am just trying to make sure that the numbers you use in talking one-sixth are not some apples and oranges numbers. Another $8 million of that is for overall safety and technology work, partly related to the advanced light-water reactors, and $18 million is for the specific advanced light-water reactor projects.

Mrs. Lloyd. But with the commitment of the industry in a near-term project, this sort of commitment for a nuclear metal reactor program—are you telling me, Mr. Vaughan, that the utilities just can't wait to deploy LMRs, the problems of reprocessing fuel?

Mr. Vaughan. First we were on what is the best path for near-term restoration of the option. We were comparing the budget for advanced light-water reactors and high temperature gas-cooled reactors, which was the initial question. If you look towards the effort for the advanced liquid metal reactors in the second part of your question, we believe those have the potential for increased passive safety.

We have done some demonstrations. That potential is as great as for the high temperature gas-cooled reactors, and for the long-term, it has a better potential for conserving our uranium resources, which someday will——

Mrs. Lloyd. The total LMR budget is $123 million.

Mr. Vaughan. No, I believe the total budget for advanced reactor R&D in FY 1988 is $70.7 million, of which $5 million is for the HTGR.

Mrs. Lloyd. But there is $52 million——

Mr. Vaughan. And then the balance is for the advanced LMR program.

Mrs. Lloyd. There is $52 million in facilities. This is a near-term technology.

I have one final question that I would like to get back to, and that is getting back to the AVLIS program, which was zeroed out in your budget. Going back to the first page of your testimony, Mr. Secretary, you talk about the guidelines for prudent management. These include confining our support to the essential activities which are properly the responsibility of the Federal Government and withdrawing those activities where the justification of the Federal role is weak.

Well, it seems to me that, according to the testimony that this committee has heard in previous years, that we are looking at a program of roughly $400 million when there will not be payoff for 20 years. I asked industry representatives last year if they would make such an investment. They said flat no.

So I really can't understand your insistence on taking the money out of the AVLIS program and at the same time insisting on this repayment back to the Treasury.

Mr. Secretary, we are going to be out of the enrichment business. There is no other way if we continue on this course, and this concerns me greatly.

Secretary Herrington. Let me comment on that. I appreciate your bringing it up. The whole reason the money is out of AVLIS is because I share your feeling. I think we are going to be out of the enrichment business.

Mrs. Lloyd. Do you want to be out of it?

Secretary Herrington. No, I don't, but let me tell you something. If we are going to be out of it, I don't want to spend this money on AVLIS, and it looks to me like we are going to be out of it. There are four major problems that have not been dealt with by Congress, industry, and the Department of Energy. We have four major issues in front of us that look to me like they aren't going to be resolved.

Number one is the payment to TVA every year for demand charges. This year we are going to pay them $550 million for electricity that we do not draw, and that charge amounts to $55 per SWU in cost. We can't be competitive with that charge.

Number two, the miners' suit, if it goes against the Government, we are out of business.

Number three, the repayment to the U.S. Treasury. Depending on who you talk to—me, you, Madam Chairman, or OMB—you can get an answer all the way from $7 billion down to $300,000.

Finally, the ban on importing South African uranium.

We can't do business in this environment, and if we are not going to be able to solve these problems, let's get out of it. My personal recommendation is that Congress and the executive branch move forward to solve these four issues now, that we set up a private or a public corporation, either one, to run an enrichment business that is unencumbered by these problems; and until we do that, let's not put any more money into AVLIS or any other enrichment technology.

Mrs. LLOYD. Mr. Secretary, we are in a very precarious position. Our allies who have done business with us are seeing that our support for the program is waivering. We are losing more and more business every day. To just zero this program out, I think, is unconscionable at this time. I think that we should try a little bit harder.

It is my understanding that you did not request this money from OMB.

Secretary HERRINGTON. I think a better statement would be that we told OMB that we needed to look at the total issues, and if they can be solved, we would like to go forward with AVLIS; if they can't, we would not like to go forward with AVLIS. I think you are quite correct. I have utilities calling me and I am sure you have them saying, "we are good customers of the United States Government, and we have to go to France now and get some of our enrichment services because you are not competitive anymore."

I think that is very true, and if we continue to go along in this vein with these problems and that program, we are fooling ourselves. It is a situation of throwing good money after bad, and I would rather try to work those out this year. I think we are at a pivotal point.

Mrs. LLOYD. Mr. Secretary, I really want to work this out with you this year. I hope that we can have a meaningful dialogue in committee and also meet to go forward with our enrichment program. I think it is critical to not only our international posture but our national security, as well.

Secretary HERRINGTON. I would agree, and I look forward to working with you.

Mrs. LLOYD. I would encourage you to really think again and again and really consider this very prayerfully because this is an important decision.

Thank you for being here.

Are there further questions?

Mr. KONNYU. Yes. Thank you, Madam Chairman.

Mr. Secretary, the Stanford Linear Accelerator is in my District, and about two months ago, there were headlines, partly erroneous, but nevertheless headlines in our area, in the Bay area, about the reduction suffered in the operation of the linear accelerators, the two that are operating in Stanford, and that for the future fiscal year, the schedule is that the new accelerator that is just being completed will be operated throughout the fiscal years, and the two others will be operated respectively six months and three months of each fiscal year.

Now, given that story and given the competition for funds generated by the new Superconducting Super Collider, the $35 million that was mentioned, what are the Department's plans for keeping those existing accelerators operating?

Secretary HERRINGTON. My feeling is that the SLAC administration is happy with the contract so far and that we are fully funding what they need funded. That said, if you have a new accelerator of the magnitude of SSC in 1996, which requires an operating budget, some of those—and I am not trying to single out SLAC, I am trying to take all the high energy programs—some of those are going to have to be cut back because work that is going on there today will go on at the new project.

I think that is a logical extension of what we are saying when we say we are going to build the SSC. But I think that is highly speculative. I know of no cutback in SLAC or any of those operations.

Mr. KONNYU. Okay. Now, I thought I detected an inconsistency in what you just said. That is that in the future, that they will have to be cut back, the existing accelerators, for the sake of the new one.

Secretary HERRINGTON. I would think that is a logical extension of what I am saying—it seems realistic. I won't be in this job at that point. Hopefully, you will.

Mr. KONNYU. Thank you. That is very kind of you.

Secretary HERRINGTON. I am looking at the SLAC budget here that Betty is giving me, and there is an increase of $17.0 million in SLAC in 1988, including SLC.

Mr. KONNYU. You don't mean billion. You mean million, don't you?

Secretary HERRINGTON. Yes. I am losing track of my objectivity.

Mr. KONNYU. After all the billion dollar things, yes. So in terms of the employees at SLAC, should they be—in terms of, let's say, three, four years or five years down the road, should they be preparing resumes? Is that what you are saying?

Secretary HERRINGTON. Absolutely not.

Mr. KONNYU. So then how do you reconcile what you said with—

Secretary HERRINGTON. The employees at SLAC, I assume that there will still be work for them at SLAC. I don't know what new programs they have on the drawing boards. If they are going to be Federal Government employees on our DOE rolls, I think that is a minor part of it, but if they are on Stanford's payroll, I have never heard of Stanford them letting a good person go. They are usually moving them into other areas.

I noticed in a recent publication that Stanford is going to raise $1 billion or $100 million for a whole new physics center between now and 1995. That is targeted right at that particular area.

Mr. KONNYU. So I can conclude, then, by saying that yes, there will be a shifting of resources to the new Superconducting Super Collider from a U.S. standpoint, and that there will be a commensurate or partly commensurate decrease in other areas, but that that is so far down the line that we really don't have any specific plans to demonstrate how all that is going to be done.

Secretary HERRINGTON. I think that is correct.

Mr. KONNYU. Thank you, Mr. Secretary.

Secretary HERRINGTON. Thank you.

Mrs. LLOYD. Are there further questions? Any comments?

[No response.]

Mrs. LLOYD. Again I would like to thank you, Mr. Secretary, for being with us today. I hope we can meet more frequently this year because there are major overriding issues. Thanks to Mr. Vaughan and Ms. Sheehan, Mr. Bauer, Donna Fitzpatrick, and who did I miss? Would you identify?

Secretary HERRINGTON. Jim Decker from Energy Research.

Mrs. LLOYD. I want to thank all of you for being here, and thank you for your testimony, and I would also like to express my appreciation to staff for a job well done.

If there are no further comments, we are adjourned.

[Whereupon, at 11:36 a.m., the hearing was concluded.]

1988 DEPARTMENT OF ENERGY AUTHORIZATION

WEDNESDAY, MARCH 18, 1987

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Energy Research and Development,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:32 p.m., in room 2318, Rayburn House Office Building, Hon. Marilyn Lloyd (chairman of the subcommittee) presiding.

Staff Present: Kathleen Lewis; Nelson Milder; Harlan L. Watson; R. Thomas Weimer.

Mrs. **Lloyd**. The subcommittee will come to order. We want to welcome you, ladies and gentlemen, to the hearing this afternoon on this almost beautiful spring afternoon. It may be pretty hard for you to stay inside, but we are glad that you are here.

This afternoon we will be receiving testimony from five of our major national laboratories and I want to welcome each of you. Of course, Dr. Zucker, who is the Associate Director of the Oak Ridge National Laboratory in my home district and Dr. Wiley who is Director of the Pacific Northwest Laboratory in Mr. Morrison's district, and he will be along shortly. Dr. Samios, who is Director of the Brookhaven National Laboratory, is back with us again this year. Dr. Schriesheim who is Director of the Argonne National Laboratory and Dr. Shirley as well. We welcome all of you this afternoon.

We look forward to hearing your summaries of your progress. I would expect some of the problems that the multi-program labs are facing in light of the recent budgetary constraints.

Over the years that I have been Chairman of the Energy Research and Production Subcommittee which is now the new Energy Research and Development Subcommittee, it has become rather increasingly clear to me and I'm certain to all of my colleagues on this committee, the important role that our national laboratories play within the Department of Energy's scientific and technological research and development missions.

Each of your laboratories is replete with very competent and superior technical expertise covering a broad range of scientific and technical disciplines with broad technical problem solving capabilities.

Now we must more than ever look to our national laboratories to provide the technology base that will allow this Nation to expand its potential economic markets both here as well as abroad and also to provide the scientific and technical expertise that we need to assist our universities, so they can perform their educational responsibilities as well.

Certainly, with the highly successful national user facilities at the laboratories such as the synchrotron light sources, nuclear research reactors and other comparable facilities, our United States industry is performing research that is leading to new advances in materials development, biological engineering and certainly to a host of other accomplishments.

We as the authorizing committee for such activities really applaud the great progress that has been made in the years in all of these efforts.

I am very concerned that the Administration as reflected in the Department of Energy's budget guidelines, the Congress and perhaps even more broadly, even more importantly, the public, just really aren't aware of the long-range implications that are associated with the declining technological and scientific R&D support in so many areas, just what it means to us not only as a nation but to our entire world.

The purpose of this hearing, as you are aware, is to provide a forum to allow the national laboratories to state their case in this new Congress and plus to permit all of our members to get a better appreciation not only of our laboratories' capabilities, their responsibilities as well as your specific concerns.

I know, for example, that you were required to prepare institutional plans to cover a period of five years from 1987 to 1992. I hope this afternoon that you will describe the basis for this planning activity and more importantly, how to use it within the Department of Energy to establish priorities and then the long range plans that eventually come to us in the Congress for approval.

I'm interested in whether the programs that we have established within the budgets that are provided are really sufficient to attract to our laboratories the high-level technical talent that we need to implement these programs.

I also hope you will be able to discuss with us the cooperative programs that you maintain between the universities as well as the private sector and then to identify the areas for us in which technology developments of these laboratories, which is so important to me, has moved out into the private sector, in ways that will enhance our national economy and the real buzz word this year, our competitiveness.

Indeed, our competitiveness is a major concern of this Congress in so many ways. I have the belief that although we are extremely technologically innovative, that we really haven't become as efficient as we could in moving innovation to new products and processes by which we can really compete in the international marketplace.

The x-ray lithography initiative which has been proposed, I think, is a classic example of the roles and the critical area that you can play in. I think it is also an example of why patent policy is very high on my agenda as well. On the other hand, I'm concerned that perhaps we are transferring technology one way, that we are transferring it outward to our foreign allies and perhaps we are sacrificing to some extent the opportunity for our domestic markets to really get the benefit from our federally-supported initiatives and our programs.

I do look forward from hearing from all of you this afternoon and the matters that concern you. Now I would like to turn to my distinguished colleague, the Honorable Sid Morrison, from Washington.

Mr. MORRISON. Thank you, Madam Chairman. I am delighted to have this opportunity to hear from our national laboratories. This team in front of us spent $1 billion this last year and a workforce of over 17,000 scientists. I think it is probably, Madam Chairman, one of America's best kept national secrets, the work done by our national laboratories.

They provide a foundation for technological and scientific development in this nation and research at these laboratories contributes to our industrial competitiveness, as our Chairman just described, energy security and national security.

Research into high energy physics, nuclear physics and basic energy sciences are rarely recognized for the significant contributions they make to our national economy.

I'm particularly proud in my own area, of the Pacific Northwest Laboratory, who is making a major investment on an initiative to enhance their basic science programs. Part of this initiative is a molecular science research center. The center will bring together theoreticians with expertise in computer modeling with experimentalists in the physical and life sciences. This use of computer experiments and the coupling of experimental verification with theory is central to research at the center. I know the other laboratories are pursuing outstanding work in this area as well and I look forward to hearing from all of you.

The national laboratories are also helping to solve our energy problems, research into advanced reactor concepts including the present generation of light water reactors that is being conducted at the national laboratories in conjunction with other DOE and industry facilities. Research into wind turbines, conservation, solar and other renewable energy resources and energy storage systems are all being supported by you gentlemen from our national laboratories.

The challenge to develop new ideas and opportunities to train American scientists and engineers is extremely important. The success of your laboratories and the future of this country's industrial competitiveness depends upon meeting this challenge.

I would like to particularly welcome Bill Wiley here today representing the Pacific Northwest Laboratory and I look forward to the testimony from all of you.

Thank you, Madam Chairman.

Mrs. LLOYD. Thank you very much, Mr. Morrison.

PANEL: MULTIPROGRAM NATIONAL LABORATORIES

Mr. LLOYD. I would like to welcome again Dr. Alex Zucker from the Third District of Tennessee. You may proceed.

STATEMENT OF DR. ALEXANDER ZUCKER, ASSOCIATE DIRECTOR, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TN

Dr. ZUCKER. Thank you very much, Madam Chairman.

My name is Alex Zucker. I am Associate Director of the Oak Ridge National Laboratory. I am pleased and honored by your invitation to testify before the Subcommittee on Energy Research and Development.

First, let me address the Department of Energy's proposed budget for general science and research and supporting research for FY 1988.

It is good to see that in spite of the difficult constraints forced on the budget by the large deficit, both the Congress and the Administration continue to support basic science. I think the people of the United States will be amply rewarded by the things that go on under this rubric.

In materials science, for example, we find new insights into high temperature alloys and ceramics, exciting results in surface and near-surface research and decisive advances in the U.S. research capabilities of building front line large research tools at Berkeley, Argonne and at Oak Ridge.

In the chemical sciences, following the recommendation of the Pimentel Report, "to assure future access to abundant and clean energy sources," we are addressing catalysis and surface chemistry, combustion science, coal chemistry, photochemistry and electron transfer chemistry.

Atomic physics is enjoying a renaissance because of the new probes that have become available: lasers, synchrotron light sources and beams of multiply charged ions. I would point out a need though that this country has for a heavy ion storage ring to study collisions between ions and photons, ions and electrons and atoms, both for the intrinsic importance of the research and for its relationship to fusion and to potential SDI concepts.

In geosciences, the scientific drilling program is revealing many important features of geology of the western United States and I hope that will be extended to the eastern United States. Through geochemical research, we are gaining new understanding of the way in which hydrocarbons were formed and how they migrated to their present locations.

In engineering research, the robotics program has in just a few years reached a position of leadership in this discipline and serves as a center of knowledge and expertise for many programs within the Department of Energy but also in other Federal agencies such as the Department of Defense and NASA.

In my opinion, the Office of Basic Energy Sciences continues to manage the program in a very enlightened fashion, attacking important goals, setting the right priorities, supporting high quality researchers and research teams and maintaining an excellent pool of large and small equipment.

I want to turn briefly to nuclear physics, where we again see DOE's management to be exemplary. Current DOE plans appear to be particularly praiseworthy. With CEBAF, this country will have the premiere research establishment for the study of nuclei with electrons and the proposed Relativistic Heavy Ion Collider at

Brookhaven will provide our nuclear physicists with the wherewithal to investigate the very high energy density regime of nuclear matter.

I only regret that we cannot expect either machine to be on line until the early to mid-1990's. We would dearly love to start that kind of research immediately.

At this point, I would like to respond to some of the specific questions you have raised in your invitation. First, the institutional planning process. The institutional planning process provides an excellent and constructive effort to communicate the laboratories' views to the Department of Energy and ultimately plays a significant role in the development of the Department's budget estimates.

The planning process forces the laboratories to examine their futures realistically and to prioritize their own programs in the light of fiscal constraints and scientific and technological opportunities.

DOE feedback is an essential part of this dialogue. The whole process brings discipline to budgeting and I believe it benefits us all.

I would also like to commend the Director of Energy Research for his on-site reviews. It is hard work for him and his associates but it is most valuable.

The institutional plan process introduces a measure of competition between the laboratories both for funding and for the acceptance of new ideas as they are generated by the laboratories. This competition is healthy and has resulted in more effective management both at the laboratories and at DOE.

The institutional plan is not the only way in which laboratories communicate and help develop the Department's budget estimates. Each division of BES reviews the laboratories' programs in detail through site visits, presentations or review of proposals. Funding, staffing, future plans and new directions are discussed on these occasions along with the technical merit and the progress of current research.

At ORNL, we put very high priority and a high premium on planning. It is something we believe in because it has served us well. Planning is conducted at all levels within the laboratory. Our senior planning group consists of a laboratory director and associate directors, and spends approximately 70 hours per year in executive sessions laying out strategic issues and directions for the laboratory as a whole. Believe me, we would not spend 70 hours in an exercise of this sort if we did not think it was important.

The results of these efforts are reflected in the ORNL institutional plan. We prepare this document annually and it contains in addition to the 5-year plan, a 15-year strategic view. Based on the planned overall directions for the laboratory, each of our research divisions develops a 5-year plan of their own every two or three years. You can see the Oak Ridge National Laboratory is big on planning and I believe it helps us, I believe it helps the Department and I think in the long run, it helps the progress of science and technology.

Since the theme of this hearing is the review of the DOE programs in general science and supporting research, I cannot resist the opportunity to describe for you a few of the results we have obtained at Oak Ridge in the last year.

Let me start with nuclear physics where ORNL was one of the leading partners at CERN last November in an experiment in which 3,000-GeV oxygen ions bombarded gold nuclei. The experiment was designed to see whether in such collisions one can get enough energy into a very small volume and boil out quarks and gluons. I think we have accomplished half of the experiment.

Preliminary analysis shows that we have indeed succeeded in creating a very hot region in a very small volume. We have evidence for an energy density of 2- to 3-GeV per cubic fermi. This corresponds to a temperature of 10^{12}-10^{13} degrees in that volume. That, I believe, is the highest temperature ever achieved by man or woman on this planet. It is many orders of magnitude higher than the 100 million degrees one associates with fusion.

Some very unexpected things happen in research. Take, for example, our materials science funded program in neutron scattering. A few months ago in a collaboration with Harvard and Forsythe Dental Center in Boston, we looked at collagen, which is the principal organic component of bone. It's the part of bone that does the biological work. So far, the results have shown how minerals link up in bone formation and studies are underway on the effect of Vitamin C on bone formation, which is well known but not understood, and on the mechanism of osteoporosis.

Collagen cannot be studied with x-rays because x-rays are absorbed or scattered by the much heavier mineralized component of bone. Neutron probes become the method of choice.

In atomic physics, we have achieved a world mark by producing a nanoampere of gold 131—sorry, of gold 31+. This capability is useful for studies related to the DOE fusion program and for injection into a heavy ion storage ring for atomic physics, whose acronym is HISTRAP, which I hope you will hear about next year when we propose it as a project for fiscal 1989.

Let me turn to something quite practical at this point; research in mass spectrometry supported by Chemical Sciences has led to the development of an instrument that can sniff for and identify explosives. This new instrument is small, it is as sensitive as the best dogs, and unlike dogs, it never gets tired. We expect this work now supported by Safeguards and Security, to find widespread application in military as well as civilian installations. We are currently building a phone booth like prototype inspection station to use at the Y-12 plant.

Madam Chairman, I have here a picture of a phone booth like enclosure where a person steps in and in one and a half seconds examination, the mass spectrometer system can tell whether there is one part per billion of TNT, a truly remarkable device that I think will find much——

Mrs. Lloyd. That is very remarkable, if you would like to pass it around to the members.

Dr. **Zucker** [continuing]. Application——

Mrs. Lloyd. We would like to see it and we will have it included in the record of the hearing.

[The photo mentioned above follows:]

Mr. MORRISON. Madam Chairman, perhaps it would work for other products that we are concerned about in this day and age.

Dr. ZUCKER. No, sir, it won't because it is specific for explosives, for reasons I would be glad to get into, if you ask me the question.

Mrs. LLOYD. Enhance our national securities perhaps at airports or is it designed——

Dr. ZUCKER. It would be great for security at airports. We use it in the weapons plant. It can be used industrially or for DOD security purposes. It will keep people from walking into an area with explosives in their pockets or their bags.

Mrs. LLOYD. It might be good around this Capitol as well.

Dr. ZUCKER. Sorry?

Mrs. LLOYD. It might be very welcome around this Capitol itself.

Dr. ZUCKER. Right. I think it will be welcome in a lot of places. In the applied mathematical sciences, we are now a leading player in parallel computing, a new way of ordering many small computers to replace one large one. We have been able to show that for many classes of large computation, parallel systems can be faster and an order of magnitude cheaper than current practice. In fact, our mathematicians by using a small $300,000 parallel computer routinely get twice the efficiency of a large vector machine like the Cray.

Mrs. LLOYD. How would this change the market for the large computers?

Dr. ZUCKER. Well, I believe the large computers—

Mrs. LLOYD. And the basic understanding.

Dr. ZUCKER [continuing].—To go into parallel structures and I think that is underway but I think we are now looking at about a $750,000 parallel system which for a large class of calculations will be as capable as a $7 million Cray.

Mrs. LLOYD. Very good.

Dr. ZUCKER. An order of magnitude savings is in the cards and I think it is very promising.

Mrs. LLOYD. Very good. Thank you.

Dr. ZUCKER. We are particularly gratified that our engineering center called CESAR, funded by Engineering Sciences, has after only three years of existence achieved national and international prominence in the field of intelligent machines. CESAR is gaining fame for developing robots with high reasoning and problem solving power to operate in unstructured environments and to deal with unanticipated events with its own powerful computer.

As you know, Madam Chairman, most robots deal with a structured system, they can do certain things repetitively. This one almost thinks for itself.

I now turn to a subject which is of great importance to ORNL, namely its reactors. As you must all know by now, the flagship of U.S. research reactors, the High Flux Isotope Reactor, is in trouble. Its pressure vessel is embrittled and several committees are currently reviewing whether it is safe to start it up again and under what circumstances.

I am confident there are several scenarios which will permit safe operation of the HFIR for a number of years but perhaps at somewhat lower power. Even so, many things will have to be done to restart HFIR and to operate it safely in the coming years. All these things cost money, money that was not previously budgeted.

In FY 1988, we estimate that we will need $6.5 million additional over and above the funds that are in the President's budget proposal, to comply with the requirements of the various review committees, and allow the HFIR to continue to supply neutrons to the 220 users for research in condensed matter, polymers, superconductors, biology, crystallography, radiation effects and rare and important radioisotopes.

I cannot overstate how important it is to the Oak Ridge National Laboratory and to the community of neutron users in the country to restart HFIR so that we will have continuous neutrons until the advanced neutron source becomes a reality.

The second reactor is the Advanced Neutron Source. This is to be the world's best research reactor designed to return to the U.S. leadership in this field that had recently passed to the Europeans. The Advanced Neutron Source is to have a neutron flux almost 10 times higher than the nearest competition. It is to have unprecedented capability for research in neutron scattering, such as the experiments I have talked about in the bone experiments, materials irradiation and production of special isotopes. It will serve 1,000 users annually and we have embarked on a program of R&D and preliminary engineering this fiscal year, when Congress voted $2.5 million for this purpose.

We find ourselves in a quandary in FY 1988 when we require $7.7 million to continue an orderly program which will culminate in a reactor ready for operation in 1996. We find to our chagrin that the President's budget request contains only $3 million. We believe that $7.7 million is essential to accomplish our objectives in this area.

I have some statistics on how much attention the laboratory pays to our relations to universities. I believe we have covered this material a number of times before. I would just like to draw your attention to page 12 and the table on that page.

Finally, let me go to the matter that you stressed, Madam Chairman, the emphasis on technology transfer. Many of you know that ORNL places a great deal of emphasis on this subject and that we work very hard to place the laboratory, its unique modern equipment and its highly expert staff into a position to help the Nation's industry in selected areas.

There are many obstacles to forging an alliance between a DOE laboratory and a commercial firm or group of firms. Some of these have been overcome. After all, during the past few years, we at ORNL have collaborated with dozens of industrial scientists, in several cases in such a manner that industry received the patents or patent licenses from the collaboration.

Two recent ventures have started in this area. One is CAMDEC in the ceramics area, whose purpose it is to conduct generic manufacturing engineering development and processing of advanced ceramic materials, to develop and demonstrate advanced techniques for integrating highly automated manufacturing technology with ceramic processing.

We expect CAMDEC to become a reality this summer. Industry appears willing to invest money in it and it is an idea, I believe, whose time has come, and I have a few brochures that I will be glad to show you, that you can read.

The other center we are starting is one on advanced processing science together with the semiconductor processing industry. While CAMDEC is pretty well advanced, in the area of semiconductors, industry is receptive but still a little tentative at this stage. Nevertheless, ORNL is proceeding with five separate bilateral arrangements with IBM, Motorola, Honeywell and the Eaton Corporation.

We are making progress. There is a slowly growing perception in industry that national laboratories can provide effective R&D for them and there is a parallel and growing realization in Government that DOE national laboratories can play an unique and perhaps decisive role in our nation's struggle to enhance its world position in trade and industry. The question is how.

Our present arrangements are, I believe, but pale shadows of what could be a purposeful and aggressive engagement of the national laboratories in this country's industrial economy.

I urge this Committee to inquire into this matter and to help forge a technology alliance between industry and the national laboratories, a technology alliance that will result in industry and Government pulling together for the betterment of all our people.

Thank you, Madam Chairman.

[The prepared statement of Dr. Zucker follows:]

DOE FY 1988 BUDGET AUTHORIZATION

Alexander Zucker
Associate Director
Oak Ridge National Laboratory

Testimony Before the
Subcommittee on Energy Research and Development
Committee on Science, Space, and Technology

March 18, 1987

TESTIMONY BEFORE THE
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
March 18, 1987

My name is Alexander Zucker. I am Associate Director of the Oak Ridge National Laboratory. I am pleased and honored by your invitation to testify before the Subcommittee on Energy Research and Development.

First let me address the Department of Energy proposed budget for General Science and Research, and Supporting Research in the Basic Energy Sciences for FY 1988. It is good to see that, in spite of the difficult constraints placed on the budget by the large deficit, the Administration and the Congress continue to support basic science. The DOE through the BES program supports research in some of the most promising areas of energy-related science. In materials science, for example, we find new insights into high temperatures alloys and ceramics, exciting results in surface and near-surface studies, and decisive advances in U. S. research capabilities by building frontline large research tools at Berkeley, Argonne and Oak Ridge. The Chemical Sciences, following the recommendation of the Pimentel Report "...to assure future access to abundant and clean sources of energy...", are addressing the following areas: catalysis and surface chemistry as the basis for new processes in the fuels and pollution control areas; combustion science as the basis for more efficient and less polluting combustion devices; coal chemistry as the basic for new approaches to synthetic fuels; and photochemistry and electron transfer chemistry as the basis for solar energy conversion and storage.

Atomic physics is enjoying a renaissance because of the new probes that have become available: lasers, synchrotron light sources, and beams of multiply charged ions. There is a need, in this country, for a heavy ion storage ring to study collisions between ions and photons, electrons, and atoms both for the intrinsic importance of the research and for its relationship to fusion and to potential SDI concepts.

In the important area of geosciences, the scientific drilling program is revealing many important features of the geology of the Western U. S. Through geochemical research we are gaining a new understanding of the way in which hydrocarbons were formed and how they migrated to their present locations.

The Robotics Program in Engineering Research has in just a few years reached a position of leadership in this discipline and serves as a center of knowledge and expertise for many programs in DOE and for other Federal agencies such as DOD and NASA.

In my opinion the Office of Basic Energy Sciences continues to manage the program in an enlightened fashion, attacking important goals, supporting high quality researchers and research teams, maintaining an excellent pool of equipment, all with sufficient flexibility to tackle new areas that always arise in science.

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Nuclear Physics continues to flourish under DOE management. To be sure the small accelerators have nearly vanished from university physics departments; in their stead we now see a few select larger facilities functioning as user centers. With the able advice of NSAC (Nuclear Science Advisory Committee) both DOE and NSF have built new accelerators. Current DOE plans appear to be particularly praiseworthy: with CEBAF this country will have the premier research establishment for the study of nuclei with electrons, and the proposed Relativistic Heavy Ion Collider (RHIC) at Brookhaven will provide our nuclear physicists with the wherewithal to investigate the very high energy density regime of nuclear matter. Unfortunately we cannot expect either machine to be on line until the early to mid-1990s, even though we would dearly love to start the research immediately. I also believe that there is a strong need for a new Heavy Ion Accelerator in the energy range between present accelerators and RHIC.

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The situation on the technology side of the DOE budget is not nearly as bright as what we see in the basic sciences. Big problems are created by continuing cutbacks in various research programs.

The reactor program is dominated by old mortgages on large facilities and the lack of support has severely limited the number of new ideas and new options that could be brought to bear on the U. S. nuclear program. If this course is maintained, the country that has given birth to nuclear power will become increasingly dependent for new advances on Japan, France, Germany and the U. K. Of specific importance to ORNL in the Fission Program is that the Advanced Control program, ACTO, is almost at a standstill in spite of the fact that it tackles specifically those aspects of nuclear energy that led to the serious accidents at Three Mile Island and Chernobyl.

The Administration's budget in Conservation is overly restrictive. DOE's Conservation programs have been exceptionally successful and perhaps the brightest spot in the record of the last few years. The Conservation Program is successfully saving hundreds of millions of dollars (c.f. DOE Energy Conservation Multi-year Plan) and its programs promise a continuation of these sterling accomplishments.

The Fusion Program, while it is limited in funding and after some painful belt tightening, is once again undertaking a new project, the Compact Ignition Tokamak.

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At this point let me respond to the specific questions that you have asked in your letter.

Institutional Planning Process.

The institutional planning process provides an excellent and constructive method to communicate the Laboratories' views to the Department of Energy and ultimately plays a significant role in the development of the Department's budget estimates. The planning process forces the Laboratories to examine their futures realistically, and to prioritize their own programs in the light of fiscal constraints and scientific and technological opportunities. DOE feedback is of course an essential part of this dialogue. The whole process brings discipline to budgeting and benefits us all. I would like to commend the Director of Energy Research for his On-Site Reviews. It is hard work for him and his associates, but it is most valuable. Discussions and personal contacts during this review enhance communication and clarify questions that may have been unclear in the institutional planning process. Priorities, limits, scientific opportunities, institutional and fiscal constraints, all get an airing in open and illuminating dialogue. The Institutional Plan process introduces a measure of competition between the Laboratories both for funding and for the acceptance of new ideas that are generated by the Laboratories. This competition is healthy and has resulted in more effective management both at the Laboratories and at DOE.

The Institutional Plan is not the only way in which Laboratories communicate and help to develop the Department's budget estimates and projections in the Basic Energy Sciences Programs. Each Division of BES reviews the Laboratories' programs in detail through site visits, presentations, or reviewable proposals. Funding, staffing, future plans, and new directions are discussed on these occasions, along with the technical merit and progress of current research.

At ORNL we put high priority and a high premium on planning - it is something we believe in because it has served us well. Planning is conducted at all levels within the Laboratory. Our Senior Planning Group - consisting of the Laboratory Director, Executive Director, and Associate Directors - spends approximately 70 hours per year in executive sessions laying out strategic issues and directions for the Laboratory as a whole. The results of these efforts are reflected in the ORNL Institutional Plan; this document, which is prepared annually, contains a fifteen-year "strategic view" as well as more detailed plans for the next five years. In addition to the senior management effort, four to five person-years of staff work are required each year to develop the Laboratory's long-range plan.

Closely associated with the Institutional Plan is the Laboratory's annual Site and Facilities Plan. This document integrates the long-term research directions with the facilities needed to carry out the research programs. The site and facilities planning effort requires approximately two person-years of work each year.

Based on the planned overall directions for the Laboratory, each of our research divisions develops a five-year plan every two to three years. As you would expect, these plans tend to be somewhat more detailed than the Institutional Plan. Although the approach varies somewhat from division to division, division managers usually put a good deal of personal effort into the division's long-range planning effort.
In addition to the strategic planning, our program managers put considerable effort into operational planning. Most of the time this planning work is done as a part of the sponsors' planning activities.

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The Administration has just recently approved the Superconducting Super Collider, a large and costly research installation for high energy physics. There is some feeling in the research community not connected with this area of physics that the new collider will draw funds from other areas of science and thus denude the country of programs in the kinds of science and technology that are perhaps more immediately connected with our economy and our welfare. I do not share that apprehension. I believe it is not the intent of the Administration nor of the Congress to neglect other areas of science in order to support one large high energy physics facility. In fact, there is ample evidence for this. The Administration has proposed and the Congress has approved, at least in a limited way, the creation of large new facilities at Berkeley, Argonne and Oak Ridge which will further in very important ways the basic study of condensed matter, chemistry, and biology, and applied research in polymers, semiconductors, and magnetic materials. I see no erosion for support of science and, in fact, I see a greater recognition that the frontiers in science are not simply in astrophysics and high energy physics but that there are equally exciting and important frontiers in chemistry, in materials science, geoscience, computers, and engineering research. Moreover, it is becoming increasingly clear that these areas of research offer intellectual challenges of the highest order and at the same time yield results that in a few years can be applied to practical problems.

What is New and Noteworthy at ORNL

Since the theme of this Hearing is the review of the DOE programs in General Science and Supporting Research, I can not resist the opportunity to describe for you a few results we have obtained at Oak Ridge in the last year.

ORNL was one of the leading partners at CERN last November in an experiment in which 3,200 GeV oxygen ions bombarded gold nuclei. The experiment was designed to see whether in such extremely high energy nucleus-nucleus collisions one can get enough energy into a very small volume and boil out quarks and gluons. Preliminary analysis shows that we have indeed succeeded in creating a very hot region in a very small volume. Over a nuclear volume with dimensions on the order of fermis (10^{-13} cm) we have evidence for an energy density of 2-3 GeV/fm^3. This kind of energy density corresponds to a temperature of 10^{12} - 10^{13} degrees in the small volume. This temperature is four or five orders of magnitude higher than the 100 million degrees one associates with controlled fusion and is in fact the highest temperature ever achieved on earth.

Some very unexpected things happen in research. Take, for example, our Materials Science funded program in neutron scattering. A few months ago in a collaboration between ORNL, the Harvard Medical School, and the Forsythe Dental Center in Boston, neutrons from the Oak Ridge High Flux Isotope Reactor were used to study collagen, the principal organic component of bone. So far, results have shown how minerals link up in bone formation, and studies are under way on the effect of vitamin C on bone formation, and on the mechanism of osteoporosis. Collagen cannot be studied with X-rays because the X-rays are absorbed or scattered by the much heavier mineralized component of bone. Neutron diffraction then becomes the method of choice.

In atomic physics we have achieved a world mark by producing one particle nanoampere of Au^{31+} (gold atoms with 31 electrons missing). This capability is useful for studies related to the DOE Fusion Program and for injection into the Heavy Ion Storage Ring for Atomic Physics (HISTRAP) we would like to propose for FY 1989.

Research in mass spectrometry supported by Chemical Sciences has led to the development of an instrument that can sniff for and identify explosives. This new instrument is small, it is as sensitive as the best trained dogs, and unlike dogs it never gets tired. We expect this work, now supported by DOE Safeguards and Security, to find widespread application in military as well as civilian installations. In fact, we are building a phone-booth-like prototype inspection station to be used at the Y-12 plant in Oak Ridge.

In the Applied Mathematical Sciences we are now a leading player in parallel computing, a new way of ordering many small computers to replace one large one. We have been able to show that for many classes of large computation, parallel systems can be faster and an order of magnitude cheaper than current practice. In fact, our mathematicians, by using a small $300 thousand parallel computer routinely, get twice the efficiency of large vector machines like the Cray.

We are particularly gratified that our Center for Engineering Systems Advanced Research (CESAR), funded by Engineering Science, has after only three years of existence achieved national and international prominence in the field of intelligent machines. CESAR is gaining fame for developing robots with high reasoning and problem-solving power to operate in unstructured environments and to deal with unanticipated events with its own powerful computer.

Geoscientists at ORNL have discovered that petroleum and natural gas often migrate as aqueous acetates and not as oil or methane. This discovery will help us understand petroleum and natural gas geology and may well result in more intelligent exploration.

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I turn now to research reactors at ORNL.

As you must all know by now, the flagship of U. S. research reactors, the High Flux Isotope Reactor (HFIR), is in trouble. Its pressure vessel is embrittled and several committees are currently reviewing whether it is safe to start it up again and under what circumstances. I am confident that there are several scenarios which will permit safe operation of the HFIR for a number of years, but perhaps at somewhat lower power. Even so, many things will have to be done to restart HFIR and to operate it safely in the coming years. All these things cost money, money that was not previously budgeted. In FY 1988 we estimate that we will need $6.5 million additional (over and above funds that are in the President's Budget proposal) to comply with the requirements of the various review committees, and allow the HFIR to continue to supply neutrons to the 220 impatient users for research in condensed matter, polymers, superconductors, biology, crystallography, radiation effects, and production of radioisotopes.

Even before we knew about the limited life of HFIR we proposed to DOE to build an Advanced Neutron Source. This is to be the world's best research reactor designed to return to the U. S. leadership in this field that had recently passed to the Europeans. In brief, the Advanced Neutron Source is to have a neutron flux approaching 10^{16} neutrons/cm^2/sec or almost ten times higher than the nearest competition; it is to have unprecedented capability for research in neutron scattering, materials irradiation and the production of special isotopes. When completed, we hope in 1996, it will serve about 1,000 users annually. We embarked on a program of R & D and preliminary engineering for the Advanced Neutron Source in FY 1987 when the Congress voted $2.5 million for this purpose. In FY l988 we require $7.7 million to continue an orderly program which will culminate in a reactor ready for operation in 1996, but we find to our chagrin that the President's budget request contains only $3 million. We believe that $7.7 million is essential to accomplish our objectives.

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It may be of interest to the Committee how much attention we pay to our relations with Universities. I simply want to highlight this aspect of our operations: the full story would take too much space and perhaps a separate hearing. In brief, ORNL interacts with universities in five primary ways: (1) collaborative research sponsored by subcontract awards, (2) shared User Facilities and resources, (3) student and faculty research participation and training, (4) special relationships with selected institutions, and (5) ad hoc enhancement of campus resources. In FY 1986, 1,633 requests for guest assignment were processed, up 16% from FY 1985. Of these, about 1,025 spent time doing research at ORNL (Table I).

Table I

Guests and Part-Time Employees at ORNL
from Educational Institutions, FY 1986

Graduate Students	450
Undergraduate Students	200
Faculty	300
Post Doctorates	60
High School Students	2
High School Teachers	13
	1,025

It is worth noting that one of the two High School students was just named Third Place Winner of the Westinghouse Science Talent Search.

Many members of this Committee know how much emphasis we at ORNL place on technology transfer, how hard we have worked to place the Laboratory, its unique modern equipment, and its highly expert staff, into a position to help the Nation's industry in selected areas. There are many obstacles to forging an alliance between a DOE laboratory and a commercial firm or a group of firms. Some of these obstacles have been overcome. After all, during the past few years we at ORNL have collaborated with dozens of industrial scientists, in several cases in such a manner that the industry received the patents or patent licenses from the collaboration. Two recent ventures in this area may be of interest to the Committee. One, CAMDEC (Ceramics Advanced Manufacturing Development and Engineering Center), proposes a cooperative R & D venture between ORNL and the structural ceramics industry to develop advanced manufacturing technologies for that industry. The other, ASPC (Advanced Semiconductor Processing Center), proposes a similar relationship between ORNL and the semiconductor processing industry. Short synopses of the two new initiatives follow.

CAMDEC, Inc., a newly formed technology development consortium for U. S. companies, has targeted a technology gap impeding the production of reliable and reproducible advanced ceramic products on a commercially viable basis. The Core Technology Program of the Tennessee not-for-profit corporation has as its primary objective the development of a highly flexible and fully instrumented processing line, initially for whisker-reinforced alumina, but also to include silicon nitride composites and other materials as determined by its industry-governed Board of Directors. The processing line requires the development of generic technologies, such as new sensing and control technologies, but it also will be available to its members for conducting company proprietary R & D. CAMDEC's flexible processing line will provide U. S. industry with a national test bed for developing and testing the manufacturing processes for their advanced ceramic products. The concept of CAMDEC and its Technology Plan was developed with the assistance of an Advisory Board of key executives from six companies: Allied Signal, Boeing, Dow Chemical, GTE Products, Norton, and Standard Oil Engineered Materials.

A primary feature of CAMDEC, Inc. is its proximity and its accessibility to the technology, capabilities, and facilities at the Oak Ridge National Laboratory and its new $20 million High Temperature Materials Laboratory (HTML). The Department of Energy and its Oak Ridge contractor, Martin Marietta Energy Systems, Inc., strongly support the initiation of CAMDEC and have worked with CAMDEC to develop all the necessary policies and procedures to permit ready access to its facilities. We view CAMDEC as a new and exciting mechanism for transferring ORNL technology to industry and as a means for contributing to the improvement of our Nation's international competitiveness.

The second interesting venture is in the field of semiconductor processing. The idea again is to help industry, in this case the semiconductor industry, to remain competitive internationally. Two meetings were held at the National Academy of Sciences in which industry R & D managers outlined their situation and representatives from four National Laboratories - Oak Ridge, Berkeley, Brookhaven and Sandia - presented their Laboratories' capabilities. No conclusive arrangements were made, but it was obvious that the Laboratories could assist in maintaining a strong U. S. position in as vital an area as semi-conductors, and that industry is receptive albeit a little tentative at this stage. Nevertheless, ORNL is proceeding with five separate bilateral arrangements with (1) IBM and Eaton Corporation, (2) Motorola and IBM, (3) Motorola, (4) University of Illinois and Motorola, and (5) Honeywell and North Carolina State. Four of these collaborative projects will utilize the ORNL Surface Modification and Characterization Laboratory.

We are making progress in this field. There is a slowly growing perception in industry that National Laboratories can provide effective R & D for them, and there is a parallel growing realization in Government that the DOE National Laboratories can play a unique and perhaps decisive role in our Nation's struggle to exhance its world position in trade and industry. The question is how? Our present arrangements are, I believe, but pale shadows of what could be a purposeful and aggressive engagement of the National Laboratories in this country's industrial economy. I urge this Committee to inquire into this matter and to help develop an explicit alliance between industry and the National Laboratories.

Mrs. LLOYD. Thank you so much, Dr. Zucker. I think that Mr. Morrison would like to introduce our next witness and Mr. Fawell, our third. We are all having a good time today, to show off our constituents.

Mr. MORRISON. It is indeed a pleasure and I mentioned Bill Wiley's name in my opening statement. Bill, we have been most pleased with your leadership at Pacific Northwest Laboratory and look forward to your presentation today. I hope that by the time you are through, everyone here will be as proud of you as I am.

STATEMENT OF DR. WILLIAM R. WILEY, DIRECTOR, PACIFIC NORTHWEST LABORATORY, RICHLAND, WA

Dr. WILEY. Thank you, Congressman.

Madam Chairman, members of the Subcommittee, on behalf of the Pacific Northwest Laboratory, I am extremely pleased to be here today to discuss the Department of Energy's FY 1988 budget request for general science and supporting research as well as to describe for you some of the principal thrusts of the laboratory in the next few years.

Operated by Battelle Memorial Institute, the Pacific Northwest Laboratory is one of DOE's multiprogram laboratories. I should point out that PNL was designated by DOE as an energy research laboratory slightly over 2 years ago. This put us in the same ball park with Argonne, Brookhaven, Lawrence Berkeley and Oak Ridge, as the other laboratories in this group.

Our facilities are located in Richland, Washington with a Marine Research Laboratory located on Puget Sound, along the peninsula there.

Before I describe what the program thrusts are at PNL, I believe it would be useful to the Subcommittee for me to describe an unique relationship that the Pacific Northwest Laboratory has vis-a-vis DOE's other national laboratories.

When the Federal Government segmented its operations at Hanford in 1964, the goal of this segmentation and diversification policy was to attract several different contractors for several different scopes of work at the site. Each of the new contractors was required to invest in the local area in order to diversify the economic base from its traditional Government town approach.

Battelle Memorial Institute was selected to manage the research and development activities there at Hanford and to operate the associated facilities, which came to be known as the Pacific Northwest Laboratory.

Battelle Memorial Institute's investment in the local Tri-Cities area and in the State of Washington over the intervening 20 years, exceeds $50 million in equipment and facilities that constitutes an extension of our private contract research and development business that exists in other parts of the U.S. and Europe. The end result of this combination of Battelle-owned and Government-owned equipment and facilities is termed the consolidated laboratory.

Now, as part of this diversification process, the Federal Government established a use permit contract which allows research, whether it be sponsored by the Government or private industry, to be conducted in the most appropriate Battelle-managed facility. The use permit and the consolidated laboratory concept have served all parties well and has provided opportunities for our scientists and engineers to work on both Government and industry sponsored projects as well as to facilitate an environment to transfer technology and knowledge learned from one project to that of another. In fact, several of the technology transfer accomplishments at PNL over the years have in large part resulted from this unique contractual arrangement.

PNL is also unique among the energy research laboratories in that in addition to being a multiprogram national laboratory, it is also a technology-support laboratory to DOE's materials production and defense waste activities at Hanford. PNL also serves as the independent environmental monitoring entity for all of the DOE operations that take place at Hanford.

These various roles are synergistic and I must add enable us to perform each individual role in a better fashion.

Madam Chairman, with that background, let me describe to you PNL's current mix of programs. If I could ask Jack to put up the first vugraph.

[Slide.]

Mr. WILEY. You should see that the laboratory has relatively—a relatively equal balance among several DOE Assistant Secretaries in terms of the programs that we have.

If you would just put on the second vugraph there, I will quickly move through to the total funding.

[Slide.]

Mr. WILEY. This vugraph expands the first pie chart by showing the level of effort at the laboratory for other DOE programs at Hanford, as well as NRC, DOD and other Federal agencies. This viewgraph also shows the total effort of the laboratory in performing research and development for Government as well as efforts supporting the public and private sector conducted under the user permit contract, which I described earlier.

The sum of this research involves a staff of approximately 3,100 full time scientists, engineers and technologists.

Thank you, Jack.

[Slide.]

Over the past several years, under the leadership of Dr. Trivelpiece and his staff, the Department of Energy's institutional planning process has significantly improved the multiprogram laboratories' ability to plan for the future in a meaningful way. I think we would all agree that planning for programs funded by the Federal Government is somewhat of a volatile, indeed imprecise process. Nevertheless, the combination of activities which Dr. Trivelpiece and his staff have put together in the institutional planning process and the recognition by the Administration and Congress of the need for strong basic research programs in this country has resulted in a series of actions where the multiprogram national laboratories are making major strides in planning for the future.

In fact, all of the DOE multiprogram laboratories are in various stages of planning new projects that are intended to be major scientific user facilities for researchers from Government, university and industrial organizations. The opportunity for all segments of the research and development community to use these facilities benefits all parties and contributes to science in general.

Over the past two years, one of my principal goals has been to revitalize the basic research capabilities within the laboratory, which to be honest with you, have deteriorated with time for a variety of reasons. We have completely revitalized our exploratory research programs; we have aggressively recruited young scientists from graduate schools and mid-career scientists from industry; and we have reorganized our research staff into what are called the Technical Centers of Excellence that support DOE's missions in these areas—life sciences, materials and chemical sciences, earth and environmental sciences, and applied physics. We have received strong support for these from the Department of Energy.

Each of these centers is multi-disciplinary in nature, is oriented toward special functional areas and supports all DOE's mission areas. In addition, PNL is developing an initiative centered around the molecular sciences, which Congressman Morrison touched on just a few seconds ago. It is intended to bring together theorists and experimentalists with computational resources unknown elsewhere.

This Molecular Sciences Center is intended to draw upon the laboratory's current technical strengths and to provide a scientific resource for a whole variety of applications ranging from biology and chemistry to geosciences to physics. While the other laboratories are much further along than PNL in responding to DOE's scientific facilities initiatives, it is our long-range plan that the Molecular Sciences Research Center will evolve into a world-class scientific user facility.

Madam Chairman, one of the questions you asked us to address is the laboratory's future. The titles of our technical centers I believe best reflect the strengths of PNL and fully support the three principal missions of DOE, those three missions being national security, energy security and enhancing international competitiveness. We think the work that goes on in these centers is indeed supportive of these three key missions of DOE.

I would also mention that the focus of the programs within our Earth and Environmental Sciences Center deals with two of the most important technical challenges facing this country; that is, storage and treatment of radioactive and hazardous wastes, and the impact of energy production and other industrial processes on air, water and land that surrounds us. This technical center also becomes the focus of much of the laboratory's efforts in support of other DOE missions at Hanford.

I want to turn now to just a mention of technology transfer, which is very important to the laboratory. This committee has been very visible in its support of the value of moving the results of research from the laboratory to the marketplace. Transferring technology from the laboratory to the marketplace is a basic tenet of all research undertaken at PNL. In fact, PNL has had several successes in transferring technology to the commercial sector in the past year or so.

Two notable examples which I am proud of and would like to mention is the biobarrier piece of research which has focused on control of unwanted root growth into areas where you do not want roots to grow. Now, this research was started to prevent the ingrowth of roots, tree and other plant roots, into radioactive storage areas.

From this original goal of the research, we have expanded that, and now it includes the licensing of this technology for purposes of the design of sewer gaskets that will prevent the growth of roots into sewer pipes. Geotextile fabrics, which will prevent the roots from growing into your swimming pool, and drip irrigation systems are another example of these slow-release devices which provide an opportunity to prevent root growth without destroying the plants, and it also permits this to be released on a somewhat—for 100 years, for that matter.

Another example of technology transfer at PNL that is receiving much attention today is the in-situ vitrification process. Originally, this was developed for stabilizing low-level nuclear wastes, and this technology has been now extended to include hazardous wastes. The in-situ vitrification method is a rather simplistic process which permits you to solidify, using the soil as a medium, the waste in a particular area, thereby preventing you from having to move this from an area of high risk to an area of low risk, so to speak. It is now possible to solidify and stabilize these wastes using this in-situ vitrification process.

Mrs. LLOYD. I told Mr. Morrison I would like to visit your area and that is one of the technologies I would like to see.

Dr. WILEY. We would very much like to have you see that. It is indeed currently a very, very popular piece of technology, and I think the Department of Energy can be very proud in having supported this for the purposes of cleaning up its own waste.

The process was recently honored by the National Society of Professional Engineers as one of the outstanding engineering achievements in 1986.

In addition, the technology is the foundation for the Northwest Hazardous Waste Research Center that was recently established at Battelle's laboratories through the reauthorization of the Superfund legislation. Given the number of hazardous waste sites in the nation, we believe this technology has unlimited potential for commercialization.

Now I want to change gears and just talk for a few seconds here about the laboratory academia programs because they are also important. PNL has also been responding to the recommendations of several reports dealing with the increased investments in human and intellectual capital on behalf of science. Let me give you some examples.

Over the past few years, we have established new programs for advanced placement of high school students and high school teachers. We have a program we have termed sharing science with the grade schools, where scientists go out into the classroom and introduce youngsters from third grade up to the basic elements of science. We also invite teachers, through a program we call Residence in Science and Technology Program, where we invite high school students into the laboratory for six weeks at a time to learn new techniques and to therefore develop new curricula in science education.

One of the advances here has been the development of a new curriculum for high school students in the Richland High School, which we think will have some national implications for materials research from the materials area. So there is a high school curriculum associated with the material sciences.

While PNL is unlike some of the other national laboratories in its direct association with a university or consortium of universities, we have undertaken a series of initiatives with regional colleges and universities to perform research and to enhance the learning experiences of our future scientists and engineers in these institutions.

I would just like to point out a few of those because I think these are some unique arrangements. PNL, DOE and the Washington State University earlier this year signed a collaborative agreement to take advantage of the geographical circumstances that we have between the two institutions, and through this we have established two energy research fellowships. Each $15,000 per year and one in engineering and one in the scientific areas, and this has become the most prestigious of the scholarships at Washington State University.

In addition, the PNL Affiliate Staff Scientist Program permits university professors from not only Washington State but from the University of Washington to come into the laboratory for a semester or greater to participate in the research of the laboratory. There are several of these exchange programs underway right now.

We have just recently signed an agreement with Florida A&M, which is another interaction with a university of which we are proud. This agreement, entitled Life Gets Better, provides an outreach program for students from Florida A&M to come into the laboratory in the summer through his or her undergraduate program. In that way, the student can learn the laboratory and participate in the research projects. Now this outreach program which is extended to historically black colleges and universities is our way of contributing to the enhancement of education in the scientific area for these institutions.

Madam Chairman and members of the committee, I want to thank you again for this opportunity, and speaking as a scientist and speaking as a director of the national laboratory, these are exciting times I think in this country. I think the pendulum has swung back to the excitement that I witnessed as a graduate student in the sixties when there was a strong commitment by this country to research and development. Unfortunately, it takes a crisis like the Sputnik or a loss of jobs and trade losses or losses to our national prestige to bring us to our senses.

The erosion of support for basic research in the seventies began to manifest itself in the eighties. The Government has recognized that a greater commitment must be made by this country to research and development. I think we are intent on making that happen. I urge the committee to continue to support a strong and stable commitment to research and development. Likewise, I urge you not to let this country make the same mistakes again. The success of DOE in fulfilling its three principal missions literally depends upon this commitment. I want to thank you again.

[The prepared statement of Dr. Wiley follows:]

Statement of

DR. WILLIAM R. WILEY

Director

Pacific Northwest Laboratory

Before the

Committee on Science, Space, and Technology

Energy Research and Development Subcommittee

United States House of Representatives

Washington, D.C.

March 18, 1987

Madam Chairman and Members of the Subcommittee. On behalf of the Pacific Northwest Laboratory, I am extremely pleased to be here today to discuss the Department of Energy's FY 1988 budget request for General Science and Supporting Research and describe for you the principal thrusts of the laboratory over the next few years.

Operated by Battelle Memorial Institute, the Pacific Northwest Laboratory is one of DOE's multiprogram laboratories. I should note that PNL was designated by DOE an Energy Research laboratory slightly over two years ago, joining ANL, BNL, LBL and ORNL as the other laboratories in that group. Our facilities are located in Richland, Washington, with a Marine Research Laboratory at Sequim on the Puget Sound Peninsula.

Introduction

Before I describe what the program thrusts are at PNL, I believe it would be useful to the Subcommittee for me to describe a unique relationship that the Pacific Northwest Laboratory has vis-a-vis DOE's other national laboratories. When the federal government segmented its operations at the Hanford site in 1964, the goal of this segmentation and diversification policy was to attract several different contractors for several different scopes of work. Each of the new contractors was required to invest in the local area in order to diversify the economic base from its traditional "government town" approach. Battelle Memorial Institute was selected to manage the research and development portion of the Hanford activities and associated facilities, which came to be known as the Pacific Northwest Laboratory.

Battelle Memorial Institute's investment in the local Tri-Cities area and in the State of Washington over the intervening twenty years exceeds $50 million in equipment and facilities that constitutes an extension of our private contract research and development business that exists in other parts of the U.S. and Europe. The end result of this combination of Battelle-owned and government-owned equipment and facilities at Richland is termed the consolidated laboratory.

As part of this diversification process, the federal government established a use permit contract, which allows research--whether it be sponsored by the government or private industry--to be conducted in the most appropriate Battelle managed facility. The use permit and the consolidated laboratory concept have served all parties well and has provided opportunities for our scientists and engineers to work on both government and industry-sponsored projects, and has facilitated an environment to transfer knowledge learned from one project and apply it to another. In fact, several of the technology transfer accomplishments at PNL over the years have in large part resulted from this unique contractual basis.

PNL is also unique among the Energy Research laboratories in that in addition to being a multiprogram national laboratory it is also a technology support laboratory for DOE's materials production and defense waste management missions at the Hanford site. PNL also serves as the independent environmental monitoring entity for all of the DOE operations that take place at Hanford. These various roles are synergistic and, I believe, enable us to perform each individual role better.

Madam Chairman, with that as background, let me describe for you PNL's current mix of programs.

Laboratory Programs and Plans

Viewgraph I shows the distribution of funds in FY 1987 between the various DOE programs at the Laboratory. As you can see, the Laboratory has a relatively equal balance among several DOE Assistant Secretaries and DOE programs. Viewgraph II expands the first pie chart by showing the level of effort at the laboratory for other DOE programs at Hanford, as well as NRC, DOD and other federal agencies. This viewgraph also shows the total effort of the Laboratory in performing research and development for government, as well as the efforts supporting the public and private sector conducted under the use permit contract. The sum of this research involves a staff of approximately 3,100 full-time people.

Over the past several years, under the leadership of Dr. Trivelpiece and his staff, the Department of Energy's institutional planning process has significantly improved the multiprogram laboratories' ability to plan for the future in a meaningful way. I think all would agree that "planning" for programs funded by the federal government is a volatile, indeed imprecise, process. Nevertheless, the combination of the institutional planning process and the recognition by the Administration and Congress of the need for strong basic research programs in this country has resulted in a series of actions where the multiprogram national laboratories are making major strides in planning for the future. In fact, all of the DOE multiprogram laboratories are in various stages of planning new projects that are intended to be major scientific user facilities for researchers from government, university and industrial organizations. The opportunity for all segments of the research and development community to use "government" facilities benefits all parties and science in general.

Over the past two years, one of my principal goals has been to revitalize the basic research capabilities within the laboratory which, frankly, had deteriorated over time due to a variety of factors. We have completely revitalized our Exploratory Research program; we have aggressively recruited young scientists from graduate school and mid-career scientists from industry; and we have reorganized our research staff into what are called Technical Centers of Excellence (Life Sciences, Materials and Chemical Sciences, Earth and Environmental Sciences, and Applied Physics).

Each of these Centers is multidisciplinary in nature, is oriented towards special functional areas and supports all of DOE's mission areas. In addition, PNL is developing an initiative centered around the molecular sciences which is intended to bring together the theorists and the experimentalists with computational resources. This Molecular Sciences Center is intended to draw upon the laboratory's current technical strengths and provide a scientific resource for a whole variety of applications ranging from biology and chemistry to geosciences to physics. While the other laboratories are much further ahead of PNL in responding to DOE's Scientific Facilities Initiative, it is our long range plan that the Molecular Sciences Research Center will evolve into a world class scientific user facility.

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I should also mention that the focus of programs within our Earth and Environmental Sciences Center deals with two of the most important technical challenges facing this country - storage and treatment of radioactive and hazardous wastes and the impact of energy production and any other industrial processes n the air, water and land that surrounds us. This Technical Center is also the focus of much of the laboratory's efforts in support of other DOE missions at Hanford.

Technology Transfer

This Committee has been very visible in its support of the value of moving the results of research from the laboratory to the marketplace. Transferring technology from the laboratory to the marketplace is a basic tenet of all research undertaken at PNL. In fact, PNL has had several successes in transferring technology to the commercial sector in the last year. Two notable examples are a biobarrier research program which has focused on the control of unwanted root growth through slow release chemical technology. The original goal of the research was to find a way to prevent any vegetation from intruding into waste burial sites, but a series of other applications became evident. As a result, licenses have been negotiated for a series of totally unrelated applications in the design of sewer gaskets, geotextile fabrics, and drip irrigation systems.

Another example of technology trasfer at PNL that is receiving much attention is a program called in-situ vitrification. Originally developed for stabilizing low level nuclear wastes, the technology has been extrapolated to a whole range of hazardous wastes. The in-situ method works by placing electrodes in the ground around a particular waste site. As electricity is passed between the electrodes, the surrounding soil, rock and wastes melt to form molten glass. After the glass cools and hardens, the area can be back filled and the area returned to its original contour. The overwhelming advantage of this process is that it does not require transporting the hazardous wastes to another site.

The in-situ vitrification technology is currently being considered by a variety of commercial firms for application to hazardous waste cleanup. The process was recently honored by the National Society of Professional Engineers as one of the outstanding engineering achievements in the U.S. for 1986. In addition, the technology is the foundation for the Northwest Hazardous Waste Research Center that was recently established at Battelle's laboratories through the reauthorization of Superfund legislation. Given the number of hazardous waste sites in the nation, we believe this technology has unlimited potential for commercialization.

Laboratory-Academia Programs

PNL has also been responding to the recommendations of several reports dealing with increased investments in human and intellectual capital on behalf of science. Let me give you some examples. Over the past few years, we have established new programs for advanced placement high school students and high school teachers. Our Sharing Science with Schools Program takes the scientists from the laboratories to the classroom to "show and tell" what the latest developments are in a wide variety of subjects. An advanced version of this program enables local community college students to talk to scientists and engineers about potential careers. Through the DOE's Residence in Science and Technology (REST) Program, high school teachers spend six weeks in the laboratory developing new ideas for their curriculum for the next school year. In fact, a teacher from the local high school in Richland developed an advanced materials curriculum as part of the REST Program last year that is thought to be unique in the country.

While PNL is unlike some of the other national laboratories in its direct association with a university or consortium of universities, we have undertaken a series of initiatives with regional colleges and universities to perform research and to enhance the learning experiences of our future scientists and engineers. Let me mention some examples here as well.

PNL, DOE and Washington State University (WSU) earlier this year signed a Collaborative Agreement to take advantage of geographical circumstances and accomplish some unique objectives. We have established two Energy Research Fellowships at WSU that are currently the most prestigious for graduate students at WSU. Worth $15,000 a year, the PNL Energy Research Fellowship is awarded to one student in the School of Engineering and one student in the School of Sciences each year. In addition, the PNL Affiliate Staff Scientist (PASS) Program offers WSU faculty the opportunity to spend a semester or more in the laboratory participating in a research project of relevance to their academic field. Likewise, PNL scientists can spend a semester teaching a course at WSU.

We have just recently signed an agreement with Florida A&M, a HBCU member school. Entitled "Life Gets Better," PNL will provide a research opportunity for a student from Florida A&M at the laboratory for each summer throughout his/her undergraduate program. In that way, the student can return to the laboratory each summer and build upon his/her research from each previous year or do several research projects. Florida A&M has committed to select a new student for this program for the next three years. We believe this is another example where DOE and the national laboratories are contributing to the twin goals of working more closely with universities and promoting the development of science and technology.

Summary

Madam Chairman, and Members of the Committee. Speaking as a scientist and speaking as the Director of a national laboratory, these are exciting times. The pendulum has swung back to the excitement of the 1960's when there was a strong commitment by this country to research and development. Unfortunately, it takes a "crisis" like Sputnik or loss of jobs and trade which portends a loss of national prestige for problems to be visible and for corrective actions to be initiated.

The erosion of federal support for basic research in the 70's began to manifest itself in the 1980's. The government has recognized that a greater commmitment must be made by this country to research and development. I urge the committee to continue to support a strong and stable commitment to research and development. Likewise, I urge you not to let this country make the same mistake again. The success of DOE in fulfilling its three principal missions literally depends on this commitment.

Mrs. LLOYD. Thank you, Dr. Wiley, for your fine statement, and I wholeheartedly agree with you that we should be excited about our new commitment to research and development. But if this is to continue as competitive as our dollars are, we cannot allow what we are doing in our national laboratories to become the Nation's best-kept secret. We are going to have to really flaunt what we are doing and aggressively let the American people know the role that our national laboratories are playing in our international competitiveness as well. Thank you very much.

Mr. Fawell.

Perhaps Mr. Fawell will like to introduce Dr. Schriesheim.

Mr. FAWELL. I certainly would like to. Dr. Schriesheim is, of course, the director of Argonne Lab and Argonne Lab is located in the center spot of the universe, Madam Chairman, in DuPage County, Illinois.

Mrs. LLOYD. Repeat that, sir.

Mr. FAWELL. The center place in the universe. We really believe that out there. But as a resident of Chicago, he has fast become one of the movers and shakers in the DuPage County and suburban Cook and Will County area, also in a number of business and other civic organizations including, Madam Chairman, a vice-chairmanship of the Science Tech Advisory Committee which this congressman badly needs in this area which is such an outstanding committee with people such as Dr. Schriesheim and Dr. Lederman leading it, and others that we literally have standing room only when we have our advisory committee meetings.

But it is a great pleasure for me to introduce Dr. Schriesheim to this committee and may I apologize right away, Alan, by saying that I have to rush off to a Group 92 budget meeting, but I do have a few questions I would like to propound to you so I hopefully shall be back before the panel completes their testimony.

Thank you, Madam Chairman.

Mrs. LLOYD. Thank you very much, Mr. Fawell, and I would like to tell Dr. Wiley and Dr. Schriesheim that they are very fortunate because their representatives work hard on this committee and they are proud of you but I think you ought to be proud of them as well. I am sure you are. Please proceed.

STATEMENT OF DR. ALAN SCHRIESHEIM, DIRECTOR, ARGONNE NATIONAL LABORATORY, ARGONNE, IL

Dr. SCHRIESHEIM. Thank you Congressman Fawell. Madam Chairman and members of the subcommittee, I am pleased to have this opportunity to testify today on the budget request of the Department of Energy for fiscal year 1988.

Overall, the 1988 budget request for General Sciences and for Basic Energy Sciences appear to be balanced. I am particularly pleased by the Department's follow-through toward starts for four major new research facilities which were announced last year.

The fiscal year 1988 budget provides $18 million dollars in construction funding for the Advanced Light Source to be built at Lawrence Berkeley Laboratory and preconstruction support for Argonne's Advanced Photon Source, Brookhaven's Relativistic Heavy Ion Collider and Oak Ridge's Steady-State Neutron Source.

The scientific and technological promise of these machines, as attested to by many peer-review and advisory panels, is truly extraordinary.

I am also pleased that the budget request includes funding for several vitally needed facility modifications and plant rehabilitations at Argonne. These projects will enable us to upgrade certain laboratory spaces, reduce utility and maintenance costs and meet environmental requirements.

I must confess though to being less sanguine about one major programmatic area in the Department's budget request, funding for research on energy technologies. Once again, substantial cuts in funding for fission, fossil, conservation and renewable technologies are planned.

This comes at a time when R&D by the Nation's energy companies is also contracting, and when oil imports are rising. I will comment on this issue further when I discuss Argonne's advanced reactor program.

Now I wish to comment on the Advanced Photon Source which will be the centerpiece of Argonne's programs in the basic energy sciences for years to come.

It is a large facility capable of generating many x-ray beams. It will provide unprecedented intensity for up to 200 simultaneous experiments and this advanced facility will be crucial for maintaining U.S. international competitiveness in industrial research, basic research and defense-related research in a wide variety of applications.

These include structural and electronic materials, investigation of biological systems and medical diagnosis.

Several national panels have designated the Advanced Photon Source as the highest priority facility for U.S. materials-related research. Better materials are the foundation for progress in most areas of technology.

Now an indication of the number of different applications of the Advanced Photon Source is the diverse attendance at the First Annual Users Meeting held at Argonne in November 1986. Among 295 participants were representatives of 38 universities and 20 of the Nation's highest-tech industrial firms.

The scientific and technical interests represented included advanced materials, semiconductors, lithography, catalysis, geology, medical imaging, bioengineering and investigating the structure of key biological macromolecules such as viruses and proteins.

Industries represented ranged from steel, ceramics and semiconductors to oil products, nuclear energy, pharmaceuticals and drugs.

Research interest in synchrotron radiation generally and in the Advanced Photon Source in particular were ably presented to this committee on March 4th by Dr. Arthur Bienenstock from Stanford, Paul Horn from IBM and David Moncton from Exxon.

Dr. Moncton, who chairs the Users Organization Executive Committee for the Advanced Photon Source, estimates that industry alone is spending between $20 and $30 million dollars annually to exploit the scientific potential of Brookhaven's National Synchrotron Light Source.

Explosive growth of demand for synchrotron radiation already has saturated existing U.S. capacity. Dr. Moncton recommends rapid progress on the Argonne Advanced Photon Source stating and I quote, "It is difficult to imagine a project which touches so many areas of science and technology relevant to industrial competitiveness, national health and defense, and basic research in physics, chemistry and biology."

He estimates that the machine will be fully subscribed with a few years of initial operation.

Argonne plans to begin construction of the Advanced Photon Source in fiscal year 1989. Last year our formal Conceptual Design Report was intensively reviewed by a special scientific committee organized by the Department of Energy specifically for that purpose.

This major milestone was passed very successfully as was a follow-up validation review conducted by the Office of the DOE Assistant Secretary for Management and Administration. The design is now being refined in close consultation with future users from industrial firms, universities, and other national labs.

Preconstruction R&D, which is being pursued across a broad front, includes development of working prototypes for key facility components. Total cost of construction is estimated at $375 million dollars which includes $70 million dollars for the effects of inflation.

This estimate is consistent with a documented estimate developed by independent study panel. Now we request $11 million dollars in fiscal year 1988 to complete preconstruction R&D and design studies and to continue development of our technical resources for a full construction start in fiscal year 1989.

I would like to point out that the Advanced Photon Source builds on Argonne's successful experience with large accelerator-based user facilities. Our Intense Pulsed Neutron Source, a first of its kind machine, has established high standards for user friendliness, enabling researchers from industry, universities and other national labs to perform their experiments with minimum delay and trouble.

We are also proud of ATLAS, the first accelerator in the world to use superconducting linac technology to accelerate heavy ions. In its design energy range, ATLAS is preeminent.

This pioneering facility was completed in 1985 on schedule and within budget. It now supports a vigorous research program involving over 200 outside users mainly from the university community.

I am confident that Argonne's development of the Advanced photon Source will continue our tradition of excellence in construction and operating major scientific facilities.

The laboratory as I mentioned earlier is also pursuing research on specific technologies that hold promise of the kinds of breakthroughs in performance and cost reduction needed to reduce the Nation's vulnerability to energy price shocks and supply disruptions.

These technologies include revolutionary concepts for fuel cells and electric batteries, techniques for reducing erosion and corrosion to improve the performance and extend the lifetimes of advanced coal technologies and new fission-reactor and fuel-reprocessing technologies.

Our largest program in energy technology is the Integral Fast Reactor. Its emergence over the last three years has fundamentally changed the direction of U.S. research on advanced nuclear reactors.

The IFR has the potential to provide our Nation with a virtually inexhaustible source of energy at competitive costs and with vastly improved safety and environmental characteristics.

Argonne's R&D program amounts to the development of a complete reactor system, inherently safe, a new fuel cycle and using new waste-processing technologies.

The demonstrations of inherent safety, conducted at our Experimental Breeder Reactor in Idaho last April were of historic importance. Extraordinarily severe accident conditions were initiated, and the reactor simply shut itself down without damage of any kind.

These results were in stark contrast with the consequences of the accident at Chernobyl later that month.

Dr. Till, the associate laboratory director in charge of our reactor programs, testified this morning before this subcommittee that our progress on all phases of the Integral Fast Reactor over the past two to three years has been spectacular.

The technical accomplishments have laid the foundation for the United States to develop a successful new generation of nuclear reactors. Both corporations selected by DOE to develop new concepts for advanced reactors, General Electric and Rockwell, have incorporated the IFR concept into their designs.

I believe, Madam Chairman, that the success of the IFR demonstrates what a national laboratory with the necessary facilities and expertise can achieve through a focused, dedicated effort on an advanced technology project.

The IFR concept was conceived at Argonne. The program was laid out by Argonne and the work was carried out by our people.

It is the kind of a program that generates its own momentum but there is still much work to be done. The next major milestone is demonstration of the practicality of the entire fuel cycle.

The required facilities are already in place at Argonne-West in Idaho and the Department's fiscal year 1988 budget provides the necessary equipment and construction funding.

Unfortunately, the operating budget for Argonne-West is substantially less than required to continue this program. I believe that continued support for the IFR is crucial for the Advanced Reactor Development Program. By following through on this program, the United States can regain its leadership in the development of advanced reactor technology.

Now I would like to briefly comment on another research area that has recently developed and is in the newspapers, Argonne scientists as well as scientists at other national labs are contributing to the recent phenomenal advances in superconducting materials.

Because the new ceramic materials reach zero resistivity at much higher temperatures than previous materials, it should be possible to develop superconducting systems whose refrigeration costs are only a fraction of what they are today.

Potential applications include electricity generation and storage, transmission systems, electric motors and electromagnets, fusion systems and others.

Now at Argonne we are already at work on techniques to fabricate new materials synthesized and tested by our basic scientists supported, the basic work supported by Basic Energy Sciences. We have been fabricating these into bars, strips and wires for use in electrical conductors and devices and I have here an example of a wire that we have fabricated using technology developed in the production of our ceramic fuel cell.

This wire is an example, I believe, of directions we should be moving in in a technology development program based on the basic research program. Because the potential—I should point out that in order for that to be a practical system, it has to carry current at some field and that is only an initial fabrication of wire that has yet to really demonstrate a current carrying capacity.

I am convinced though with a program, that can be done. What I would like to recommend, Madam Chairman, because the potential economic payoff is so large, I recommend that the Department of Energy consider establishing a national research and technology development program to exploit the opportunities afforded by these new superconducting materials and utilize the national laboratories, of course, as a vehicle to do this.

Now in terms of technology transfer and that is what we are talking about, Argonne inventions are moving to market more quickly than they did in earlier years because of enlightened Congressional legislation, new administrative procedures at the Department of Energy and new organizations at Argonne and I might just touch lightly on this.

Two key organizations at Argonne are its Technology Transfer Center and an independently managed not-for-profit corporation called ARCH. That is a unique operation. It is funded jointly by Argonne and it is operator, the University of Chicago.

In fact, the University has dedicated income from part of its endowment to support the initial operation of ARCH.

In the last two years, the Technology Transfer Center has screened 281 invention reports. Seventy were referred to ARCH for their commercial potential. ARCH selected 44 of these inventions, and asked DOE to waive its rights. This step is necessary so that ARCH, of course, can offer private investors incentives such as exclusive licenses.

ARCH has been exercising considerable flexibility and originality in negotiating arrangements with private companies. I have in my written testimony a number of examples of technology that is currently in the ARCH portfolio that is in the process of being transferred, and rather than go through that, I recommend that you look at that.

Mrs. Lloyd. That will all be included in the record of the hearing.

Dr. Schriesheim. It will all be included in the record?

Mrs. Lloyd. That is right.

Dr. Schriesheim. In passing, I might say in the past three years some 15 inventors, budding entrepreneurs, have left Argonne National Laboratory to set up private companies in the immediate area, and I view that as a real asset to the area and to the Nation.

I also have in my written testimony some numbers on the extensive involvement we have with the university system, and that is also in the written testimony.

Madam Chairman, as you can well appreciate, the national lab system is a priceless leaf, I feel, in the Nation's science and technology portfolio. The labs represent an investment which the Nation has made in the past, makes today and, I trust, will continue to make in the future.

I believe that the returns from the enterprise have been extraordinary, and as director of one of these labs, and also as a taxpayer, I urge the members of the subcommittee to continue their strong support.

Thank you.

[The prepared statement of Dr. Schriesheim follows:]

Testimony Before the

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT OF THE HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

by

Alan Schriesheim
Director of Argonne National Laboratory

March 18, 1987

Madam Chairman and Members of the Subcommittee, I am Alan Schriesheim, Director of Argonne National Laboratory. I am pleased to have this opportunity to testify today on the budget request of the Department of Energy for FY 1988.

Argonne is a large multiprogram laboratory, operated by the University of Chicago for the Department of Energy. Of our 3700 employees, about 1400 are research scientists and engineers. Our facilities are located at two sites -- one near Chicago, Illinois, the other near Idaho Falls in eastern Idaho. We have strong programs both in basic research and in a number of areas of advanced energy technology.

In my comments today, I shall tell you about several of Argonne's important research programs, our progress in technology transfer, and some of our work with the nation's academic institutions. But before getting to these particulars, I offer some general comments about the Department's budget for FY 1988.

Overall, the FY88 budget requests for General Sciences and for Basic Energy Sciences appear to be balanced. They provide for reasonable growth, despite the nation's budget-deficit problems. I am particularly pleased by the Department's follow-through toward starts for four major new research facilities, which were announced last year. The FY88 budget provides $18 million in construction funding for the Advanced Light Source, to be built at Lawrence Berkeley Laboratory, and preconstruction support for Argonne's Advanced Photon Source, Brookhaven's Relativistic Heavy Ion Collider, and Oak Ridge's Steady-State Neutron Source. The scientific and technological promise of these machines, as attested by many peer-review and advisory panels, is truly extraordinary. The Department is to be congratulated on its leadership, particularly its coordination with other federal agencies and its oversight of planning by the national laboratories.

I am also pleased that the budget request includes funding for several vitally needed facility modifications and plant rehabilitations at Argonne. These projects will enable us to upgrade certain laboratory spaces, reduce utility and maintenance costs, and meet environmental requirements.

I must confess to being less sanguine about one major programmatic area in the Department's budget request: funding for research on energy technologies. Once again, substantial cuts in funding for fission, fossil, conservation and renewable technologies are planned. This comes at a time when R&D by the nation's energy companies is also contracting, and when oil imports are rising. Over the short term, we seem condemned to lurch back and forth between two very unattractive energy scenarios: either (i) low energy prices and rising energy imports, implying a growing vulnerability to energy shocks, or (ii) high prices and a great deal of economic and political pain. We are still a long way from the low-cost, "backstop" technologies needed to solve this problem.

Resisting a natural inclination to elaborate on this situation, I return to the more positive part of the budget. I shall describe first our progress on Argonne's Advanced Photon Source, one of the major new facilities mentioned above.

Advanced Photon Source

The Advanced Photon Source is the most important scientific initiative at Argonne. It will be the centerpiece of our programs in the energy sciences for years to come. A large facility capable of generating many x-ray beams, it will provide unprecedented intensity for up to 200 simultaneous experiments. This advanced facility will be crucial for maintaining U.S. international competitiveness in industrial research, basic research, and defense-related research -- in a wide variety of applications, including structural and electronic materials, investigation of biological systems, and medical diagnosis. Several national panels have designated the Advanced Photon Source to be the highest-priority facility for U.S. materials-related research. It is not an exaggeration to claim that better materials are the foundation for progress in most areas of technology.

An indication of the remarkable number of different applications of the Advanced Photon Source is the diverse attendance at the First Annual Users Meeting, held at Argonne in November 1986. Among 295 participants were representatives of 38 universities and 20 of the nation's "highest-tech" industrial firms. Scientific and technical interests represented included advanced materials, semiconductors, lithography, catalysis, geology, medical imaging, bioengineering, and investigating the structure of key biological macromolecules such as viruses and proteins. Industries represented ranged from steel, ceramics and semiconductors to oil products, nuclear energy, pharmaceuticals and drugs.

Research interest in synchrotron radiation generally and in the Advanced Photon Source in particular was ably presented to this Subcommittee on March 4 by Arthur Bienenstock (Stanford), Paul Horn (IBM), and David Moncton (Exxon). Dr. Moncton, who chairs the Users Organization Executive Committee for the Advanced Photon Source, estimates that industry alone is spending between $20 million and $30 million annually to exploit the scientific potential of Brookhaven's National Synchrotron Light Source, which had an initial construction budget of $24 million. Explosive growth of demand for synchrotron radiation already has saturated existing U.S. capacity. Dr. Moncton recommends rapid progress on the Argonne Advanced Photon Source, stating "It is difficult to imagine a project which touches so many areas of science and technology relevant to industrial competitiveness, national health and defense, and basic research in physics, chemistry, biology, etc." He estimates that the machine will be fully subscribed within a few years of initial operation.

Argonne plans to begin construction of the Advanced Photon Source in FY 1989. Last year our formal Conceptual Design Report was intensively reviewed by a special scientific committee organized by the Department of Energy specifically for that purpose. This major milestone was passed very successfully, as was a follow-up validation review conducted by the Office of the DOE Assistant Secretary for

Management and Administration. The design is now being refined in close consultation with future users from industrial firms, universities, and other national laboratories. Preconstruction R&D, which is being pursued across a broad front, includes development of working prototypes for key facility components. Total cost of construction is estimated at $375 million, which includes $70 million for the effects of inflation. This estimate is consistent with a documented estimate developed independently by a national design study panel. We request $11.0 million in FY 1988 to complete preconstruction R&D and design studies, and to continue development of our technical resources for a full construction start in FY 1989.

The Advanced Photon Source builds on Argonne's successful experience with large accelerator-based user facilities. Our Intense Pulsed Neutron Source, a first-of-its-kind machine, has established high standards for "user friendliness," enabling researchers from industry, universities, and other national laboratories to perform their experiments with minimum delay and trouble. We are also proud of ATLAS, the first accelerator in the world to use superconducting linac technology to accelerate heavy ions. In its design energy range, ATLAS is preeminent. This pioneering facility was completed in 1985 on schedule and within budget. It now supports a vigorous research program involving over 200 outside users, most from universities. I am confident that Argonne's development of the Advanced Photon Source will continue our tradition of excellence in constructing and operating major scientific facilities.

I will now describe some of the laboratory's work on advanced energy technologies, especially our recent progress on the Integral Fast Reactor.

Advanced Energy Technologies

The laboratory is pursuing research on specific technologies that hold promise of the kinds of breakthroughs in performance and cost reduction needed to reduce the nation's vulnerability to energy price shocks and supply disruptions. These technologies include revolutionary concepts for fuel cells and electric batteries; techniques for reducing erosion and corrosion to improve the performance and extend the lifetimes of advanced coal technologies; and new fission-reactor and fuel-reprocessing technologies.

Our largest program in energy technology is the Integral Fast Reactor. Its emergence over the last three years has fundamentally changed the direction of U.S. research on advanced nuclear reactors.

The IFR has the potential to provide our nation with a virtually inexhaustible source of electricity at competitive costs and with vastly improved safety and environmental characteristics. Our R&D program amounts to developing a complete reactor system -- inherently safe reactor, a new fuel cycle, and new waste-processing technologies. The demonstrations of inherent safety, conducted at our EBR-II last April, were of historic importance. Extraordinarily severe accident conditions were initiated, and the reactor simply shut itself down without damage of any kind. These results were in stark contrast with the consequences of the accident at Chernobyl later that same month.

As Dr. Till testified before this Subcommittee earlier this morning, our progress on all phases of the IFR over the past 2-3 years has been spectacular. The technical accomplishments have laid the foundation for the United States to develop a successful new generation of nuclear reactors. Both corporations selected by DOE to develop new concepts for advanced reactors -- General Electric and Rockwell -- have incorporated the IFR concept into their designs.

The success of the IFR demonstrates what a national laboratory, with the necessary facilities and expertise, can achieve through a focused, dedicated effort on an advanced technology project. The IFR concept was conceived at Argonne; the program was laid out by Argonne; and the work was carried out by our people.

The IFR is the kind of program that generates its own momentum, but there is still much work to be done. The next major milestone is demonstration of the practicality of the entire fuel cycle. The required facilities are already in place at Argonne-West, and the Department's FY 1988 budget provides the necessary equipment and construction funding. Unfortunately, the operating budget for Argonne-West is substantially less than required to continue the program.

I believe that continued support for the IFR is crucial for the Advanced Reactor Development Program. By following through on this program, the United States can regain its leadership in the development of advanced reactor technology.

In another research area, Argonne scientists are contributing to the recent phenomenal advances in superconducting materials. Because the new ceramic materials reach zero resistivity at much higher temperatures than previous materials, it should be possible to develop superconducting systems whose refrigeration costs are only a fraction of what they are today. Potential applications include: electricity generation and storage, transmission systems, electric motors and electromagnets, and many others.

At Argonne, we are already at work on techniques to fabricate new materials -- synthesized and tested by our basic scientists -- into bars, strips, and wires for use in electrical conductors and devices. Because the potential economic payoff is so large, I recommend that the Department of Energy consider establishing a national technology-development program to exploit the opportunities afforded by these new superconducting materials.

Technology Transfer

Argonne inventions are moving to market more quickly than they did in earlier years, because of enlightened Congressional legislation, new administrative procedures at the Department of Energy, new organizations at Argonne -- and much hard work by individuals now given appropriate opportunities and incentives. The two key organizations at Argonne are its Technology Transfer Center and an independently managed not-for-profit corporation called ARCH, founded jointly by Argonne and its operator, the University of Chicago. The University has dedicated income from part of its endowment to support initial operation of ARCH.

In the last 2 1/2 years the Technology Transfer Center has formally screened 281 Invention Reports submitted by Argonne researchers. Seventy were referred to ARCH for further evaluation of commercial potential -- particularly in terms of attracting private capital to support more development. ARCH selected 44 of these inventions, and asked DOE to waive its rights. This step is necessary so ARCH can offer private investors incentives such as exclusive licenses to the technology.

ARCH has been exercising considerable flexibility and originality in negotiating arrangements with private companies. For example, SARISA is a new Argonne technology that uses lasers to measure surface impurities that affect the performance of materials used for semiconductors and many other purposes. We have just signed an agreement with a commercial company that will bring one of their engineers to the laboratory to work full time for at least a year while a commercial prototype is being designed, assembled, and tested. This kind of cooperation between a national laboratory and a private company would have been impossible only a few short years ago.

Many other Argonne inventions are being propelled toward commercialization by the Technology Transfer Center and ARCH. Some of the most ambitious of these efforts are part of the federal Steel Initiative, which seeks to revitalize the U.S. steel industry with new technologies developed jointly with industry at the national laboratories. One key Argonne invention is a process that casts molten steel by levitating it in midair using superconducting magnets. The potential cost savings are substantial.

Argonne recently invented a portable toxic-gas detector that will soon enter manufacture. This rugged, inexpensive device can identify gases with a precision that formerly required a laboratory full of expensive equipment. One of the Argonne inventors left the laboratory to form his own manufacturing company. He has received an order from the Coast Guard for up to 50 instruments. Ultimately, it is likely that every fire department will want to have access to such an instrument.

An advanced fuel cell under development at Argonne is still some distance from commercialization, but its potential importance is so great that negotiations with industrial firms are already under way. This device could replace a conventional internal-combustion engine, achieving an 80 percent reduction in weight, much greater fuel efficiency, and the ability to use many different liquid and gaseous fuels.

I could give you many other examples of Argonne technologies being transferred to the private sector. However, I mainly want to make the general point that the institutions we have painstakingly established during the past three years to expedite this transfer are beginning to prove their worth. I am very enthusiastic and encouraged by their early successes.

Academic/Educational Interactions

Argonne's cooperation with academia is extensive and productive. These activities are so diverse that often their full extent and importance are not appreciated. The laboratory conducts many educational programs for undergraduates, pre-college students, and their teachers. Argonne staff collaborate on research with university faculty and their graduate students. Our research facilities serve many university faculty from across the nation. Altogether, such diverse programs bring to the laboratory each year more than 2,000 teachers, students, and researchers.

I mentioned earlier the highly successful programs that serve university researchers at our major accelerator-based facilities, ATLAS and IPNS. Along with our Electron Microscopy Center and other facilities, they bring to Argonne each year over 400 users from academia. Users of our Advanced Computing Research Facility --

numbering over 300 -- do not even have to visit us in person, since they can link up remotely to any one of five of the Center's advanced parallel computers.

In cooperation with the Midwest Universities Energy Consortium, Argonne is proposing a Multiphase Flow Research Institute. The Institute will coordinate a cohesive program of research at universities in the "Big Ten" states and at Argonne. The research is aimed at improving our understanding of multiphase flow, which can lead to improved processes for the nation's energy and chemical industries.

Madam Chairman, as you well appreciate, the national laboratory system is a priceless leaf in the nation's science and technology portfolio. The laboratories represent an investment which the nation has made, makes today, and, I trust, will continue to make in the future. The returns from this enterprise have been extraordinary. As director of one of these laboratories, and as a taxpayer, I urge the Members of the Subcommittee to continue their strong support.

PANEL DISCUSSION 1

Mrs. **Lloyd**. Thank you very much, Dr. Schriesheim. I am going to have to leave a little bit early, and Representative Chapman will be in to chair the remaining hearing, so I would like to stop at this point and ask some questions and express some of my concerns to you as well.

We are often asked why we like this job, why we run every two years, why we raise money, why we take all the abuse and letters to the editor and some of the things that just aren't very pleasant about this job, but there are many paybacks. I would say to you, and I am sure Mr. Morrison shares my feeling that one of the reasons that we run for this job and work hard is the opportunity to represent you that represent our national labs, the important role that you play in our international community and in improving the quality of life of all mankind, and really understanding the critical role that you play in our industrial competitiveness.

So you are the bright spots in our congressional careers as well.

I am very convinced that if we are to retain our position as the power of the free world and as industrial and technology giant, that we are going to have to look at some of the many reasons for our trade imbalance. To me, one of the reasons is the lack of cooperation between the Federal Government and the private sector. I think if we would look at the cooperative climate that exists in West Germany and Japan, that we would indeed see that they are not on a collision course, that they work in harmony, and that our Nation can't continue, we can't afford the adversarial role between the private sector and Government.

Now, don't get me wrong. I believe in the free market system that has made our country the great country it is, but we must also look at the problems of our generation. We do have trade imbalances. We are not taking advantage of the technology that has been advanced in our laboratories.

I do think the time is right for the national laboratories to play a very unique role in forging this alliance, and I think that we must aggressively pursue this goal. I think that one of the ways we can work to forge this alliance is to work for greater technology transfer and to aggressively work for the changes in our patent policy that are so very important to this member.

This is going to be necessary if we are going to enhance our competitiveness and make sure that our economic well-being is stabilized.

How can we get from technology innovation to new products that are competitive in the world's marketplace?

Dr. **Samios**. Let me take that on. I agree with your comment and I think we have a case in point which I am interested to find out whether it will work out, and that is x-ray lithography. Here is a perfect example. If it doesn't work out, then my confidence in us solving problems will be greatly reduced.

Everyone agrees we have a crisis. It is a case where industry says we have got to develop it, laboratories are ready to help, all the ingredients are there. The Defense Department is for it. It is a case where Japan and Germany are working on this front. It is for our trade imbalances, it is for our national security. Most labs are working on it. We in particular at Brookhaven have tried to take a lead in this. We have had workshops, and I am looking forward to a good resolution of this situation.

Mrs. **Lloyd**. I can assure you, Doctor, that this committee is also very interested in pursuing R&D and lithography. We are planning to add money in this area. It is of primary interest to us.

Dr. Zucker.

Dr. **Zucker**. As you know, we worked very hard on this, and the areas where we at Oak Ridge are interested, we are interested in materials, high temperature materials and ceramics. The system is moving, but it is moving at a non-competitive pace. In commercial development, it is not possible to wait a year or two to develop a product because by that time it will either be obsolete or somebody else in Japan will already have put it on the market.

Although it is fashionable to beat the Government on this since it is all their fault, I don't think it is. I think the bureaucracies in industry are equally dense, and it is up to both industry and government to forge this alliance. None of us is perfect.

The patent situation to me looks a little better, but let me illustrate something which might throw some light on that. As I mentioned in my testimony, we are developing a cooperative research program in ceramics with a number of industries, and the whole ceramic industry essentially says that they need a cooperative research R&D program and that Oak Ridge is a good place to do it.

Now they have to fund it, and the level of funding that we are looking at is something like $200,000 per company. To my amazement, I discovered that an R&D vice president in a ceramics company has to go to his CEO to get $200,000. He has to justify it with a profit that will accrue in two or three years and return tenfold or fifteen-fold returns.

I suggest that if we have that kind of a position in industry, if we have that kind of a time horizon, we are wasting our time. We are not going to catch up with anybody by putting our horizon out two or three years.

Mrs. **Lloyd**. Would you characterize this as industrial bureaucracy?

Dr. **Zucker**. It is industrial bureaucracy, it is worship of the bottom line, it says I'm going to have to show a profit during my tenure in office. It's that kind of thing. I think it is time to—and perhaps the subcommittee would wish to play a role in this—to ventilate all these things honestly and openly to see what is it that keeps industry from really cooperating, what is it that makes Government so slow to respond that industry can't use it?

I believe that there are only about three or four obstacles in the road, and if we could level the road, we could move ahead very rapidly. We have seen that. We now market a great many things through industry. For example, Oak Ridge, as mention was made, three or four years ago has changed the whole tool industry with ceramic tool bits.

Mrs. **Lloyd**. Dr. Wiley.

Dr. **Wiley**. I think we are making some progress on this industrial bureaucracy. There were two reasons for it. The first was that exclusive rights to the technology that was resident in the laboratories was not forthcoming in the early days. That was one thing.

The second thing is that we had an overriding "not invented here" character within the industrial environment. That "not invented here" characteristic of industry is going away, and in addition, we are able now to provide them with the kind of proprietary position that will permit them to make it work.

So I am confident that we are in transition now and that with the commitment and the kind of motivation which your subcommittee are providing from Congress, that we are going to see a marked increase in the rate at which we transfer technology to industry.

I think that we are working at both ends of the technology spectrum now. I would look at it as basic science, on the one end, and an application on the other end, and the technology transfer medium is on the far end of that technology pathway. We are making some investments in that now, and I think that will have a major impact on enhancing the rate of technology transfer.

Mrs. **Lloyd**. Very good.

Dr. Schriesheim.

Dr. **Schriesheim**. I certainly agree that progress is being made. I believe, though, that the Nation can afford to take certain risks, and where we have as a Nation taken risks, I believe that we have really had a payoff. Where have we taken risks? We have taken risks when we have decided to focus our activities.

Regardless of where nuclear power is today, it is certainly true that it was developed in the Government system, the national laboratory system, to be specific, and transferred. There are a number of examples of major transfer activities that have taken place when we have decided, as I say, to focus our activities, and to do it in what I would call a co-curring fashion: that is, both the industry and the national labs and the Government are involved, so it is not done in a consecutive fashion where first we do something and then industry does something.

So I believe that if we take a risk—and that to me means focusing on a few specifics—and attempt to generate a program on a cocurrent basis, we are liable to be successful. I have a few examples or suggestions. I am sure this panel can give you other suggestions.

I certainly agree with Dr. Samios on the x-ray lithography as an example. I have thrown another one out. My goodness, we have to be almost the first among equals in the superconductivity business because it is brand new. The Nation should take a risk, or at least if it doesn't take a risk, it should be discussed and a decision made not to take a risk.

As I say, there are others, so I would suggest you think about some specific areas where these risks might be taken, and then the problems that Dr. Wiley mentions will sort themselves out as they are worked through. I, of course, like to think that the Advanced Photon Source is such an area because it has technology transfer significance, but I am sure these other gentlemen can give you——

Mrs. **Lloyd**. That is a very exciting technology. I look forward to visiting your lab and seeing all the good things you have done.

Dr. Shirley.

Dr. **Shirley**. Madam Chairman, it is easy, speaking last, to agree with the previous speakers. In fact, I find myself in almost complete agreement. I agree particularly with Dr. Zucker that the progress is being made but that it is painfully slow, and I think it is debatable whether or not it is competitive.

I feel that industry does need to be more aware of the national laboratories. I think there should be a larger industrial presence at national laboratories, as there now is, for example, in the national facilities that are widely used by industry. I feel that the industry is going to have to increasingly depend upon national laboratories for some of the generic basic research that they might have in the past essayed to carry out themselves because it is getting more expensive and there is need for using concentrated, large facilities.

So I would suggest that any mechanisms that can be devised to induce industrial scientists to spend more time in the national laboratories and to become familiar with their capabilities would probably be well worth the investment.

Mrs. LLOYD. I appreciate your input and I hope that this will be a continuing dialogue and that we can revisit this issue before the end of the year.

Dr. Schriesheim, in your statement on page 2, you refer to the funding for energy technology, the cuts in our fission, fusion, fossil, conservation, renewable technologies and so forth. You are very concerned, as I am, that we are going to be very vulnerable to energy shocks. Do you gentlemen feel that—I mean you have given me your views on the areas of your concern in your specific labs, but are we neglecting our demonstration projects, not only nuclear but in solar and fossil energy, in our demonstration programs? How do we need to reverse this trend? We mustn't become more dependent on outside energy sources.

Dr. SCHRIESHEIM. I, Madam Chairman——

Mrs. LLOYD. Dr. Schriesheim.

Dr. SCHRIESHEIM. I don't believe there is any serious differences of opinion on the growing dependency of the Nation on external sources of supply for oil, imported oil and that particular resource, of course, ultimately should be reserved to what it does best, it is a high energy density, easily transportable liquid, or it should be, it is used in transportation systems.

The alternatives in our energy infrastructure which is oddly unforgiving, there is a large energy infrastructure in this country and it is certainly oddly unforgiving—seem to boil down to relatively few on a large scale; coal, shale, nuclear, and those should represent an energy option, a portfolio of options that need to be supported not only on a basic research standpoint but from some standpoint along the chain on out to commercialization, because it's clear that our nation's energy companies are literally disinvesting from that segment, due to a whole series of circumstances.

So in my view, of course, the options, the near-term options, those that we know we can do, coal, nuclear, shale, we need to put in place the kind of programs that will give us those technologies at lowest cost, whatever that is, and it's difficult to look at the national programs and see that.

The longer-term technologies, solar, photovoltaics, fusion, certainly need to be supported because if the Government doesn't support them, if the energy companies are not supporting these nearer-term technologies, they are certainly not supporting the longer-term technologies, so I believe that this Committee needs to assure itself that the energy supply technologies are being supported through this spectrum, the nearer-term technologies and the longer-term technologies and that there is a rational program in place to do that.

My position, the one I enunciated, is that I view our national programs and they seem each year to suffer that cut in those technologies, and it is difficult to assure oneself that when the crunch comes, as it inevitably will, we will have the lowest-cost technologies available, so we are not thrown back into the 1970's when we had the highest-cost technologies available, which we don't want.

Mrs. LLOYD. Very good. I appreciate your input.

On a more parochial area, Doctor, if you will forgive me, the Department's 1988 budget request for facility support at ORNL is about $10 million. This is a 63 percent increase but we need to restore some of our facilities and also need to do some construction, not just refurbish but we need to begin some buildings as well.

I'm concerned that this is going to inhibit some of our construction activities, especially when we look at the reality that the High Flux Isotope Reactor is in trouble and you are asking for $6.5 million for this and then we need to build the Advanced Neutron Source, which you requested $7.7 million. If we aren't about to bring in about $14 million of this, how are we going to reconcile our problem, Dr. Zucker?

Dr. ZUCKER. Well, we have some of the money for the Advanced Neutron Source, so we just need to go—we need $4.7 more so we are talking really about $11 million. I don't see a good way out. The HFIR is a very high priority device. It does things that no other reactor in the country can do.

Mrs. LLOYD. Well, members of this committee agree with you on this is a high priority item, and yet we are faced with budgetary constraints so this will be a major issue for us to resolve in this budget cycle as well.

I have over extended my time. Dr. Samios, you will proceed with your testimony at this time.

STATEMENT OF DR. NICHOLAS P. SAMIOS, DIRECTOR, BROOKHAVEN NATIONAL LABORATORY, UPTON, NY

Dr. SAMIOS. Madam Chairman, I appreciate the opportunity to testify before this Subcommittee on Energy Research and Development. I ask that my entire statement be incorporated in the record of these proceedings.

In the time allotted, I will give an overview of my testimony, commenting on the areas of general science research and supporting research and technical analysis with specific emphasis on BNL activities, planning process, the 1988 budget and some new exciting scientific results.

As you are probably aware——

Mrs. LLOYD. Without objection, your entire statement will be made a part of the record. Excuse me.

Dr. SAMIOS. Thank you very much.

As you are probably aware, these research areas, general science and basic research, constitute more than 60 percent of the Brookhaven budget, but equally important, comprise two major facility thrusts of the laboratory. That is in general science, the combination of the AGS, Tandem van de Graaff and the recently completed transfer line, give an unique capability in particle and nuclear physics.

This is to be strengthened by the booster which is under construction and the Relativistic Heavy Ion Collider, RHIC, which is planned to be started as a construction project in FY 1989.

The other major thrust is in Basic Energy Sciences. In this instance, the major facilities are the National Synchrotron Light Source, the NSLS, and the High Flux Beam Reactor, HFBR. The former is the source of the brightest beams of ultraviolet and x-ray light in the world, a world class facility, the second is a neutron source in the ranks of HFIR and Grenoble.

We are now completing the Phase II upgrade of the NSLS which will substantially increase the brightness capability of this facility and have proposals for further improvements in both the HFBR and the NSLS.

The question was posed, "What is the role that the laboratory's institutional planning process plays in the development of DOE's budget for FY 1988 and beyond?" The procedures followed are multifold and interactive. Basically, they start at the scientific level by the scientists themselves, work their way up through the Department to the directorial level. Ultimately, the decision has to be made by the directorate, hopefully in a vibrant laboratory, there are more ideas and more projects one can hopefully take on, therefore, some filtering process must take place and that fortunately or unfortunately is that the buck stops at the highest level.

Simultaneously, one has to be interactive with the users' organizations and at Brookhaven, for instance, we are a user lab where 80 percent of the work is done by outside people. In developing these plans, one works in consultation with them as well as with the pertinent program officers in DOE.

Similarly, one also has to interact with the national panels which have a responsibility for advising DOE in the general areas, such as HEPAP, NSAC and BESAC. So you see, you have users, you have your own scientists, you have your directorate, you have the program officers and you have the national panels.

The institutional planning document is an integral part of this. It forces a planning sequence over 5 years, and I would call it a necessary, but not sufficient condition for success. You have to have a good plan but that's not good enough. It must be consonant with national goals.

As you know, in addition to this, periodically, there are committees set up by the National Academy and other people, recent ones being Seitz-Eastman Panel and the Brinkman Panel on physics through the 1990's and it is also important that the plans of the laboratory be consonant with such long range plans.

At BNL, recent projects that we have had that underwent this type of activity have been the light source, the transfer line and the booster projects. In the future, what we have ahead of us, RHIC, which you have heard about, the HFBR Guide Hall and possible other improvements on our light source.

This process works quite well in general. In fact, we are rather pleased by the DOE initiatives, namely the Advanced Neutron Source for Oak Ridge, the ALS at Berkeley, the 7 GeV at Argonne and the RHIC, heavy ion collider at Brookhaven, which is an attempt to get forefront facilities at the national labs.

The frustration, of course, is the rate and frequency of implementing on agreed upon initiatives. Being a bit more specific, the booster project under construction at BNL and RHIC underwent this review, and we are ready to start RHIC in 1989. It seems to go reasonably well. On the other hand we are disappointed on the lack of a positive action on the HFBR Guide Hall, which was an upgrade program.

It went through this process. We proposed it for several years, 1986, 1987 and 1988, and it still has not succeeded in being approved. We believe this upgrade which essentially allows for 10 new instruments and more experimental floor space leaving the reactor untouched, one of the things we certainly do on Long Island, we don't touch our reactors, with the Shoreham situation—we think it is an important and vital experimental resource.

Many years ago, we pointed out the great strength in having photons and neutrons at the same place because you could study different properties and material this way. This lesson has been learned very well by our European colleagues. At Grenoble, where they have a reactor similar to HFIR and the HFBR, they are putting their new machine at the same place, because of this complementarity. We have not learned this lesson as well.

I will comment next on the 1988 budgets. High energy and nuclear are in a similar situation. Both have 13 percent increases which look very generous in this day and age but I will try to tell you it is not as generous as it seems.

I am pleased by the bold initiative by the Administration in approving SSC. I believe it is the logical next step in the multi-TeV region and I think it is a first-rate scientific facility.

I also agree with every other comment that has been made on it, that the money for this thing, the $4.3 billion, has to be on top of the budget. It has to be new money. The High Energy budget is $500 million. To build this thing, you are going to need $600 million a year. You ain't going to have anybody to use it if one doesn't do something about that.

Mrs. Lloyd. I'd like to express my concern. I'm very supportive of the Super Collider. I just do not want it at the expense of either programs that are ongoing, that are important, energy programs, and this will have to be a separate item. Next year when the big numbers—year after next when the big numbers——

Dr. Samios. 1989.

Mrs. Lloyd [continuing]. Start to appear, it will have to be a commitment by the American people for this long-term investment. This program will have to be supported by the American people.

Dr. Samios. I agree with that.

Mrs. Lloyd. It's not an agenda that your community or this Committee can make happen.

Dr. Samios. I'm glad to hear that. I agree with that.

If one looks at the 1988 budget in High Energy, it went from $500 million to $566 million, but because of the timing, the money needed, even though small for SSC is in that increase, one can argue whether it is $20 million or it is $35 million, and if one takes that out, the increase doesn't seem as large and the program is suffering and the facilities are operating marginally.

We at Brookhaven at the AGS, for instance, will operate 14 weeks, which is roughly half of what we are capable of doing. So, I would say operations are not in great shape. That's the price we are paying for this year. Hopefully, we will do better next year.

In a similar vein, in Nuclear Physics, there is a 13 percent increase going from $217 million to $245 million, again, a large fraction of that is going to really getting a good start on CEBAF, which we support, and $3 million of that also is going to helping us in the RHIC R&D, going from $3 million to $6 million. If you take that $15 million and $3 million, $18 million, out of the $28 million increase, it is really a $10 million increase for the rest of the program and again I think it is very tight and it is causing difficulty in the ongoing operations. I think it is very important that we sustain operations while we build these new facilities. We need a balance between ongoing and future promise, otherwise we are not going to have the bright people that we want to be exploiting the new great facilities we are building.

So, a balance has to be obtained and a judgment call which is difficult, but we have to constantly be alert to that.

At this point, I would like to discuss some new physics, some new results. The first has to do in high energy, or it is actually astrophysics. At Brookhaven, as part of the program to throw as wide a net as possible, we have had a strong program even in non-accelerator physics.

Some notable examples have been the BNL solar neutrino experiment which detected neutrinos from the sun but at one-third the expected rate. That difference is still not understood.

Recently two groups, one in Japan and one associated with Brookhaven, IMB, Irvine-Michigan-Brookhaven collaboration, which has a large water Cerenkov counter, has been active in a salt mine in Cleveland looking for proton decay. It just so happened in February there was a spectacular supernova explosion. This detector was active and both detectors, the one in Japan and the one in Cleveland saw neutrino events from the supernova explosion. The last time there was such an explosion was in 1604. We planned these detectors very well to be just ready for this.

That is exciting twofold. One, it will shed light on the processes by which the supernova stars explode and second, it will have placed strong limits on the masses of neutrinos which are particles which up to now were thought to have zero mass but looking at the timing of these events, will essentially place stringent limits on the order of a few electron volts upon these particles.

The second is a follow up on what any director here will talk about and this is the great excitement having to do with superconducting materials. We have been part of that. The materials used to be superconducting up to 20 degrees Kelvin and in the last year, we now have materials at least two probably more that are superconducting up to 90 degrees Kelvin.

I have examples of two. One is an yttrium ceramic and it was developed by the group at Houston and other areas and one which is leutecium, which was developed at Brookhaven and probably other areas which looks like charcoal and these are the things that I think are going to have great excitement over the next years. Again, it is unexpected and hopefully this may pretend having superconducting materials which may even go higher in temperature. So we are in the process of seeing a revolution.

The other example I want to show is what happens in a new facility. You commented earlier about technology transfer, about users, about industrial participation. Well, we built the National Synchrotron Light Source about 6 years ago and fortunately, we have taken a picture of one of the rings, the UV ring, from the same place once a year, just to see what happens as a function of time, and I'd like to show you what happens in a first-rate facility and how the users just inundate the place and the different problems you get.

Let me take a second to show you.

Mrs. LLOYD. We are happy to see your slides as well.

Dr. Samios, would you hold just a minute. If you would review the first one, because our recorder was not able to get your comments.

[Slide.]

Dr. SAMIOS. The first one shows the machine itself.

[Slide.]

The second you start seeing some of the shielding around the machine, a few of the beam lines and a few experimenters.

[Slide.]

You start seeing a slightly more crowded area one year later. These are all the beam lines coming out with different experiments.

[Slide.]

One more year.

[Slide.]

This one is particularly interesting because you will see a sign that says SSC, and we were checking the properties of tubes which are cooled to low temperatures and how happens when synchrotron radiation hits it.

[Slide.]

And finally, when you think you can't do anymore, this is the picture taken last year, and now we are starting to go vertically.

Operations of this facility for the coming year are tight but reasonable. On the other hand, funding at the HFBR will necessitate some reduction in operations.

I would conclude my remarks by noting that there are exciting scientific developments occurring in many areas at this time. Proposed new facilities promise to enhance our capabilities in high energy, nuclear and basic energy sciences. I have outlined procedures that I believe are needed for funding projects; namely, user participation, DOE program and institutional planning reviews and consistency with the national priorities as annunciated by pertinent national panels.

This is true of BNL proposals. The budget projection for FY88 for the categories being considered today appear better than they really are; namely, we are paying for SSC, CEBAF, et cetera, and operating funds are tight. I urge that there be no reductions and if remotely possible in this Gramm-Rudman era, increases in selected areas. Thank you.

[The prepared statement of Dr. Samios follows:]

Written Testimony of

Nicholas P. Samios, Director

Brookhaven National Laboratory

before the

Subcommittee on Energy Research and Development

March 18, 1987

I appreciate the opportunity to testify before this sub-committee on Energy Research and Development. The subject matter concerns the DOE budget areas of general science research and supporting research and technical analysis. As you are probably aware these research areas constitute more than 60% of the BNL budget, but equally important comprise the two major facility thrusts of the laboratory. That is, in general science the combination of the AGS, Tandem van de Graaff and the recently completed transfer line give a unique capability in particle and nuclear physics. This is to be strengthened by the booster (under construction) and the Relativistic Heavy Ion Collider (RHIC) planned to be started as a construction project in FY'89. The other major thrust is in basic energy sciences. In this instance, the major facilities are the National Synchrotron Light Source (NSLS) and the High Flux Beam Reactor (HFBR). The former is the source of the brightest beams of ultra-violet and x-ray light in the world with a user community second to none--a world class facility; the second is a neutron source in the ranks of HFIR and Grenoble. We are just completing the Phase II upgrade of the NSLS which will substantially increase the brightness capability of this facility and have proposals for further improvements in both the HFBR and the NSLS. This is the general game plan.

One of the major devices used in developing laboratory initiatives and plans is the formal Institutional Planning document prepared and discussed annually with the Department of Energy. I consider this a necessary but not sufficient requirement in the process of successfully implementing the lab's plans. It is through this and other interactive processes that the cognizant program officers and the responsible officials of OHER give feedback and advice as to the desirability and prospects for the various endeavors put forth by the laboratory. We at BNL, historically are a major user laboratory, and as such develop major facility long range plans in cooperation and sometimes at the instigation of our pertinent user organizations and their workshops. I believe it also important that any laboratory plan be consistent with national priorities as enunciated by HEPAP, NSAC, BESAC etc. and National Academy Panels. This works quite well in general. The frustration is the rate and frequency of implementation of agreed to initiatives. Being a bit more specific. The Booster Project under construction and RHIC Project under went this review process, and as I testified on March 3 specifically on RHIC, we are ready and eager to start construction in FY'89. On the other hand, we are disappointed in the lack of positive action on the HFBR Guide Hall upgrade. It has been blessed by national panels, the latest being the Seitz-Eastman and National Academy review chaired by William Brinkman--and although we proposed it for several years, namely FY'86, FY'87 and FY'88, it still has not succeeded in being approved. We believe that this upgrade which essentially allows for ~ 10 new instruments and more experimental floor space, leaving the reactor itself intact, is a very important and vital experimental resource. Many years ago we pointed out the strength of having both neutrons and photons at the same place to investigate material, chemical and biological materials--this message has clearly been adopted by our European friends in placing their new photon source at Grenoble next to their reactor. They clearly recognize their complementarity. We are now deliberating whether to continue the effort to implement such an upgrade.

On a more general note, the Administration decision to build the SSC is a positive, ambitious and important step in the field of particle physics--a necessary expansion into the multi TeV energy range. Its cost is formidable, and has been expressed at previous testimony, one has to achieve a balance between exploring new opportunities and maintaining ongoing operations. Clearly the funding for this multi-billion dollar project has to be essentially add-on monies during its construction phase. As has always been true in high energy physics, facilities not at the cutting edge are closed down to make way for new ones, and I support this procedure. The situation we face now is one of having a reduced number of operating facilities and a long construction SSC schedule > 7 years. We must assure that we perform excellent physics on the presently available forefront facilities, utilizing them as well as possible and preserving the necessary resources, including manpower, to properly exploit the SSC when it operates. This is a tall order. I am also reasonably confident that when the time comes, it will be obvious which facilities are not at the cutting edge of physics and they will be phased out. It historically has worked that way and we must be careful not to act prematurely for we may end up with the worst of all possible worlds, no ongoing facilities and a late future facility with few first rate people to properly utilize them. From these lofty plateaus one must, however, return to address the real world, namely the fiscal '88 budget for high energy physics. Although it has increased substantially by ≈ 13% one must note it contains the increased SSC funding ($16 to $35M or one can even argue $0 to $35M). As such the ongoing program is very tight. For example at BNL we are only going to be able to run the AGS for ≈ 12-14 weeks, less than half of its capability. In addition, funding for the construction of the booster has been less than desired--a pattern of $2M (FY'86), $2.5M (FY'87) and $8.3M (FY'88) leads to unnecessary stretchout and ultimately increased costs for constructing this project. I note these examples to request that no cuts be made in this budgetary category on the mistaken assumption that the consequences will be minor--on the contrary, we have difficulties and are operating somewhat marginally.

Similar comments can be made in the area of nuclear physics. The nuclear physics community thru NSAC and several National Academy Panels have proposed a consistent long range plan. This involved upgrading some lower energy university accelerators (done) and the construction of two major complementary facilities, CEBAF and RHIC. Dr. Grunder and I have already testified on these two projects, the first (CEBAF) well underway and the second (RHIC) planned to begin in FY'89. I also wish to stress a) the great importance in beginning construction of RHIC in FY'89, and b) to reiterate the importance of balance in the nuclear area similar to the remarks I have already made in high energy, i.e., maintaining utilization and present operations and allowing for new facilities at the cutting edge of science.

At this point I would like to briefly discuss some startling and important new physics results recently found by BNL scientists and their collaborations. As part of the program to throw as wide a net as possible, BNL has had a strong program in non-accelerator physics as well as those associated with large accelerators. Some notable examples have been the BNL solar neutrino experiment which detected neutrinos from the sun but at one-third the expected rate (consequences still not understood), and more recently the Irvine-Michigan-BNL (IMB) large water detector experiment searching for proton decay. Although this latter experiment has not seen such a decay, it has set the best limits on this process, it was fortunately active when a supernova star exploded this past February 1987. Nine neutrino events were detected over a time span of seconds--this amazing observation will clarify the theoretical conjectured mechanisms for such explosions and further will set limits on neutrino masses at the few e.v. level. There is a lesson to be learned from this occurrence; namely, you couldn't have planned this, the last such supernova explosion occurred in 1609! and it took several years to build such a detector. Therefore, the philosophy of funding good research and excellent researchers (with minimum interference and detailed justification), is the wise and true path to success.

Again addressing the proposed DOE FY'88 budget for nuclear physics, I would recommend that the ≈ 13% increase be supported and not reduced. On a national level this substantially increases the CEBAF construction funds. For BNL there is an additional $3M for RHIC R&D (already commented on in previous testimony) and the rest of the BNL program has a 3.2% increase, again tight.

The Basic Energy Science program at BNL is the major component of our part in the Supporting Technical Research Application area. Again our plans in this area are consonent with national goals as enunciated by review panels as well as our user wishes and our capabilities. The centerpiece at present is the NSLS--both the UV and x-ray ring are inundated with users ≈ 800 and growing. In fact this facility was a good example of support by the national and local communities, and once operational even its doubters have come to utilize its superior intensities. That's why I believe that once a clearly superior facility exists, then scientists will vote with their feet and come to it. A sequence of pictures taken at the NSLS UV ring from the same place at yearly intervals attests to this rapid build-up phenomenon. As you know the desirability of dedicated light sources is now well accepted, the question is how many and how fast. Needless to day, BNL has been very active in this area. Some of the main lattice designs, Green-Chasman and Vignola having BNL origins. Operation of this NSLS facility for the coming year is tight but reasonable. On the other hand flat funding at the HFBR will necessitate some reduction in operations, 11 cycles to 9 cycles. Again to comment on recent scientific developments, there has been a great deal of excitement in the material science area in the last months with respect to new superconducting materials. Up to recent times there were materials such as niobium titanium that possessed the property of zero electrical resistance but at low temperatures 4-10°K. First at IBM Zurich, scientists developed a rare earth combination of material that was superconducting at ≈ 35°K and more recently people at Houston and BNL have developed other material that is superconducting at ≈ 90°K. These are ceramic types of materials and we are actively studying them with both photons at the NSLS (> 6 groups) and with neutrons at the HFBR (1-2 groups).

I would conclude my remarks by noting that there are exciting scientific developments occurring in many areas at this time. Proposed new facilities promise to enhance our capabilities in high energy, nuclear physics and basic energy sciences. I have outlined procedures that I believe are needed for funding projects, namely user participation, DOE Program and Institutional Planning reviews and consistency with the national priorities as enunciated by pertinent national panels. This is true of BNL proposals. The budget projection for FY'88 for the categories being considered today appear better than they really are; namely, we are paying for SSC, CEBAF, ALS, etc. and operating funds are tight. I urge that there be no reductions and if remotely possible in this Graham-Rudman era, increases in selected areas.

CURRICULUM VITAE

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1949--Stuyvesant High School.
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Employment

Instructor, Department of Physics, Columbia University, 1956-1959.
Adjunct Professor, Department of Physics, Columbia University, 1970-Present.
Adjunct Professor, Department of Physics, Stevens Institute of Technology, 1969-1975.
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Associate Physicist, Department of Physics, Brookhaven National Laboratory, 1962-1964.
Physicist, Department of Physics, Brookhaven National Laboratory, 1964-1968.
Group Leader, Nuclear Interactions Group (Changed to "New Group"), Department of Physics, Brookhaven National Laboratory, 1965-1975.
Senior Physicist, Department of Physics, Brookhaven National Laboratory, 1968-Present.
Chairman, Department of Physics, Brookhaven National Laboratory, 1975-1981.
Deputy Director, High Energy and Nuclear Physics, Brookhaven National Laboratory, February 1981-January 1982.
Acting Director, Brookhaven National Laboratory, January 1982-May 1982.
Director, Brookhaven National Laboratory, May 1982-Present.

Honors and Awards

E. O. Lawrence Memorial Award, 1980.
New York Academy of Sciences Award in Physical and Mathematical Sciences, 1980.
National Academy of Arts & Sciences, Fellow.
National Academy of Sciences, Member.

Professional Societies

Phi Beta Kappa, Member.
American Physical Society, Fellow.
New York Academy of Sciences, Member.
Sigma Xi, Member.

Present Committees

Yale University Committee for the Physical Sciences and Engineering, Member.
International Committee for Future Accelerators (ICFA), Member.
New York State Governor's Council on Long Island Regional Economic Development, Member.

Past Committees

Evaluation Team* for Middle States Association of Colleges and Schools, Commission on Higher Education (*University of Pennsylvania), Member.
BNL Council, Member.
BNL Council, Chairman.
Program Advisory Committee, Stanford Linear Accelerator Center (SLAC).
ERDA High Energy Physics Advisory Panel, Subpanel D, Secretary.
AUI High Energy Study Committee, Member.
Princeton-Pennsylvania Accelerator Visiting Committee, Member.
National Accelerator Laboratory, Program Advisory Committee, Member.
Division of Particles & Fields, American Physical Society, Program Committee, Vice Chairman, Chairman.
Division of Particles & Fields, APS, Chairman of Division.
Division of Particles & Fields, APS, Executive Committee, Member.
SLAC Scientific Policy Committee, Member.
PEP Experimental Program Committee (of SLAC and Lawrence Berkeley Laboratory).
High Energy Physics Advisory Board (HEPAP) of DOE, Member.

Mr. **Chapman** [presiding]. Thank you, Doctor. Go ahead and proceed with Dr. Shirley.

STATEMENT OF DR. DAVID A. SHIRLEY, DIRECTOR, LAWRENCE BERKELEY LABORATORY, BERKELEY, CA

Dr. **Shirley**. Mr. Chairman and members of the subcommittee, it is a pleasure to be here today to discuss the institutional planning process at the Lawrence Berkeley Laboratory and how the scientific initiatives identified in that process are reflected in the Department of Energy's budget request.

Before proceeding further, however, I would like to acknowledge Congressman Norman Mineta for his strong support of basic research, and particularly for his kind introduction during the earlier hearings on March 3.

My testimony submitted for the record presents this discussion at some length. At this time, I will just briefly summarize both the institutional issues and LBL's scientific proposals in the context of what promises to be a very exciting year for science.

The DOE national laboratories must continuously assess their opportunities for serving the Nation based on the scientific environment and moderated by national, economic and political constraints. Possible changes in national energy policies and their consequences for the laboratories must be anticipated.

LBL's view of its environment can be summarized as follows. Number one, we realize that the Department of Energy will have to work with limited resources. The laboratory's new scientific initiatives have been developed to maximize our contributions to important national programs within a constrained Federal budget.

Number two, today's weak dollar and low oil prices have made it politically attractive to ignore our increasing dependence on imported oil and neglect research on technical alternatives for oil-consuming technologies. A clear lesson of the last ten years, however, whether the price of energy has been high or low, is that the energy production and supply industries have not invested effectively in new energy-related science or technology. Both competitiveness and national security necessitate a Federal role.

Number three, the DOE institutional planning process has been an important tool for LBL's internal planning. DOE's Office of Energy Research, especially through its Scientific Facilities Initiative, has been the DOE organization most responsive to laboratory planning. I would particularly like to acknowledge the role of outgoing OER Director, Dr. Alvin W. Trivelpiece, whom I feel has served the Nation very well in this connection. A broader DOE energy R&D planning is clearly needed.

Number four, basic research at national laboratories can make a strong contribution to economic competitiveness. At LBL, we have organized research programs that involve both the guidance and the participation of industrial scientists. Our involvement with graduate education in areas of science relative to industrial interests also meets national goals to improve competitiveness.

Number five, large scientific and engineering facilities, their development, design, construction and operation are among the most important contributions that national laboratories can make to national efforts in research and technology development.

And number six, perhaps most important, science today is lively and exciting. The need for science-based innovation in energy-related industries and others is compelling. LBL's proposed initiatives address the needs of broad segments of the scientific community.

Let's now turn to science. This is a stimulating time to be the Director of a National Laboratory. Wherever you look, things are happening that may change our daily lives as well as providing the fundamental explanation of why the world works as it does.

The laboratory's institutional plan presents scientific initiatives that combine the excitement of the new science with the laboratory's strengths and the goals of the Department of Energy's national programs. For fiscal 1988, our largest scientific initiatives are in the Basic Energy Sciences, with other important but smaller new programs proposed in the General Sciences and in Health and Environmental Research.

First, the 1-2 GeV Synchrotron Radiation Source is a third-generation electron storage ring that will provide ultraviolet and soft x-ray radiation from magnetic insertion devices. Investigators from industry and universities and national laboratories will have access to unique and powerful research capabilities. Coherent laser-like radiation with high-spectral brilliance. The facility will support up to 60 user stations for research in the life sciences, material sciences, chemistry, physics and other fields.

LBL is currently engaged in Title I design of this facility as Congress has authorized during fiscal 1987. In fiscal 1988, planned construction activities will commence, leading through a series of milestones to project completion in fiscal 1992.

Materials research conducted with close industry collaboration is emphasized at the Center for Advanced Materials, CAM, which was established in 1984. Now a part of the Materials and Chemical Sciences Division at LBL, CAM programs bring together university, industry and LBL investigators to attack materials problems of mutual national concern.

As an example, scientists in CAM's electronic materials program and LBL management are working with representatives of the semiconductor industry and the National Academy of Sciences to further the effective utilization of unique national laboratory facilities that can support the competitiveness of the U.S. electronics industry.

LBL has also led the development of heavy ion nuclear physics as a scientific discipline. This field has brought a more complete understanding of the properties in evolution of matter. Research pioneered at the Bevalac has helped to establish the foundation for the new discoveries that can be made at the Relativistic Heavy Ion Collider, RHIC, proposed by Brookhaven as part of the Scientific Facilities Initiative. However, even after the construction of RHIC, the Bevalac will provide users with exciting research advances.

To maximize these opportunities, LBL has proposed an upgrade for the existing Bevalac which will provide a cost-effective solution for meeting research needs in intermediate energy heavy ion physics. We are currently working with the Department of Energy and its scientific advisory committees to further define the possible role of the Bevalac upgrade in the long-range plan for nuclear physics research.

I am especially proud to report that LBL is also pursuing fundamental research projects that have potential for contributing significantly to long-range energy supply. The laboratory's exploratory research program on Heavy Ion Fusion Accelerator Research, or HIFAR, has been quite promising. This subcommittee heard about this program on February 25th from Dr. Klaus Berkner, our Associate Director for Accelerator and Fusion Research. HIFAR is a high priority program in LBL.

The development of high temperature superconducting materials, already alluded to several times today, may lead to entirely new energy-conserving technologies such as zero-loss transmission lines, lower-cost medical diagnosis, faster and smaller computers, and efficient high-speed trains. In parallel with several other laboratories, Berkeley scientists have recently synthesized yttrium barium copper oxide, which is superconducting at liquid nitrogen temperatures.

Professor Angelica Stacey and coworkers at Berkeley have used copper-rich starting materials to prepare samples that retain the superconducting phase after melting. This property may facilitate the manufacture of future superconducting wires with metallic properties.

I am pleased to show the committee a sample of this material. Like the other materials you have seen today, it is a small piece of ceramic material. We look forward, as part of the DOE's superconductivity research program, to maintaining this Nation at the forefront of superconducting materials research.

I think it is fair to say that this scientific breakthrough of high temperature superconductors has changed our world. We are living in a different world now than we were six months ago.

The Lawrence Berkeley Laboratory is understandably proud of the Nobel Prize in chemistry awarded this past winter to Yuan T. Lee. Professor Lee's research has been supported by the Department of Energy at LBL since 1974. He has developed advanced instrumentation based on colliding beams of molecules to study chemical reactions such as fuel combustion. This area of chemistry, termed reaction dynamics, has been identified as an important frontier in science by the National Academy of Sciences in its report, "Opportunities in Chemistry."

We are working with the Department of Energy to further push this scientific frontier through the development of advanced laboratory facilities using photon sources such as lasers and the 1-2 GeV Synchrotron Radiation Source.

LBL has also maintained a strong health and environmental research program since the 1930's. Based on current research in cellular and molecular studies of carcinogenesis, mutagenesis and DNA research, we are proposing a Human Genome Center, focusing primarily on creating a physical map of genes in human chromosomes. This Center would be part of a nationwide human genome research program proposed by the Department of Energy in its fiscal 1988 budget.

This proposed program has created a great deal of excitement in the scientific community and promises to be an important foundation for understanding hereditary illnesses and environmentally caused diseases, and for ultimately controlling many disease processes.

Mr. Chairman, I believe that the Congress and this subcommittee can and should play an important role in guiding the future of DOE's efforts in energy research and development. I hope my comments will be of some assistance. Thank you.

[The prepared statement of Dr. Shirley follow:]

Testimony of Dr. David A. Shirley
Director, Lawrence Berkeley Laboratory
before the
House Science, Space and Technology Committee
Subcommittee on Energy Research and Development
March 18, 1987

Madam Chairman, Members of the Subcommittee,

It is a pleasure to be here today to discuss the institutional planning process at the Lawrence Berkeley Laboratory and how the scientific initiatives and new facilities identified in that process are or may be reflected in the Department of Energy's budget request for FY 1988 and beyond. Since the Subcommittee is recently reorganized with many new members, I particularly welcome the opportunity to tell you LBL's story—a little of its history and a vision for its future. As part of this story, I will also address some of our achievements and some of the issues and problems facing national laboratories.

My testimony is organized to follow the three most important sections of the Laboratory's Institutional Plan—the Laboratory's mission, a strategic view of the Laboratory's environment and opportunities, and Laboratory initiatives. These sections of the Institutional Plan can have a significant influence on DOE's program and budget planning, especially in the General Sciences and the Basic Energy Science programs. They also implicitly address the Subcommittee's concerns about criteria and priority setting. In many ways, they tell the story of LBL—what it is, where it can go and how it can serve DOE's national programs.

The Lawrence Berkeley Laboratory and Its Mission

The Lawrence Berkeley Laboratory, operated by the University of California as a Department of Energy national laboratory, provides leadership for national scientific programs and supports technological innovation through its mission to:

- Perform leading multidisciplinary research in general sciences and energy sciences;
- Develop and operate unique national experimental facilities for use by qualified investigators;
- Educate and train future generations of scientists and engineers;
- Foster productive relationships between LBL research programs and industry.

Presently, in 1987, LBL has over 3,100 employees and long term guests and a total budget of $189 million. Current programs encompass all the natural sciences as well as engineering, mathematics and computer sciences. Of its $156 million operating budget, 53.9% comes from DOE Office of Energy Research programs, 8.8% from the Office of Conservation and Renewable Energy, 16.7% from other DOE programs and institutions, 8.7% from the National Institutes of Health, and 12.0% from other federal and private sponsors.

TABLE 1. Current Budget by DOE Program
($K)

Program Area	FY 1985 Actual	FY 1986 Actual	FY 1987 Projection*
Basic Energy Sciences	29,200	27,900	30,600
Nuclear Physics	29,600	28,400	28,900
High Energy Physics	17,400	17,800	18,200
Conservation and Renewables	17,700	15,100	13,600
Health and Environmental Research	8,200	8,000	7,500
Nuclear Waste Management	1,100	3,200	4,000
Magnetic Fusion	6,600	3,600	1,800
Fossil	2,600	2,000	1,800
Other DOE	12,700	18,800	16,900
Total DOE Operating	125,100	124,800	123,300
Work for Others	25,000	28,100	32,000
Total Operating	150,100	152,900	155,300
Construction and Equipment	24,500	29,200	34,200
TOTAL	174,600	182,100	189,500

*As of March 6, 1987

Located in the Berkeley Hills above the campus of the University of California at Berkeley, the Laboratory has a unique opportunity to serve the national needs for high quality scientific education and training. About 211 UC faculty members and 600 graduate students receive direct support from the Laboratory; on an annual basis, approximately 100 dissertations are completed through LBL programs. The Laboratory also operates smaller DOE-sponsored programs to enrich the educational experiences of undergraduate science and engineering students and precollege students and teachers.

The Laboratory was established in 1931 on the Berkeley campus of the University of California, when E. O. Lawrence built the world's first cyclotron. The invention launched the field of high energy physics, which probes the fundamental nature of matter. Lawrence's quest for higher energies required larger accelerators and a new style of multidisciplinary team research.

With the construction of the 184-Inch Cyclotron in 1939, the Laboratory expanded to its present site above the Berkeley campus. Over the next thirty years, LBL scientists discovered numerous subatomic particles and fourteen new elements and pioneered the fields of nuclear physics and chemistry. This research has led to many prestigious awards, including the naming of eight Nobel laureates. Through the 1950s and 1960s, LBL's programs broadened to encompass all the natural sciences of the highest scientific quality. One measure of these achievements are the 47 members of the National Academies of Science and Engineering, two recent National Medal of Science winners, and the 1986 Nobel Prize for Chemistry awarded to Yuan T. Lee.

The Lawrence Berkeley Laboratory: A Strategic View of Its Environment

The DOE national laboratories are very much at home in assessing their scientific environment and the opportunities that it offers to them and DOE's programs. Less easy to do but of equal importance is an assessment of the national economic and political constraints and opportunities facing the Laboratory. Possible changes in national energy policies and programs and their consequences for the laboratories need to be anticipated. From LBL's perspective, there are four broad overlapping areas worthy of discussion.

Persistent Federal Deficits and Changing Priorities for Research. Despite the efforts of both the Administration and Congress, we see the continuing large federal deficits as producing a great deal of uncertainty in the federal budgeting process and therefore the budgets of the national laboratories. Although basic research has been favored in this Administration compared to other domestic programs, increases for this area have come at the expense of applied research and development programs, especially in the Department of Energy. Since LBL primarily serves the DOE's basic research programs, the national increases have supported new LBL initiatives which will provide a new research focus for the Laboratory in the long run. At the same time, LBL had to reduce its staff by 500 people in the last seven years. Much of this reduction reflects changed national priorities for applied research in the conservation and renewables area. If the nation's energy R&D policy changes again in the face of increased dependence on oil imports, LBL may once again be called on to shift its resources abruptly to these programs. Such sudden oscillations are good neither for research institutions nor for the research that is produced.

The Nation's Energy Future and the Role of the Department of Energy. At the beginning of the decade, the decline of oil prices in real dollars lessened the political pressure to find technical means to change U.S. energy supply and demand patterns. However, the strong dollar still offered our international competitors and allies incentives to maintain active energy programs. Today the weak dollar and even lower oil prices, with their beneficial effects on inflation and perhaps on the trade deficit, have made it easier still to avoid facing a coming volatility in domestic oil and gas production and an inevitable dependence on imported oil by the end of the century.

Technical alternatives for oil-consuming technologies and improved means of exploration and production of domestic oil and gas supplies must be supported now. Environmentally acceptable coal technologies and the underlying materials and chemical sciences need attention before the next crisis. Though the Strategic Petroleum Reserve may mitigate the immediate economic impacts of an oil shortage, the long range solution to the nation's energy future will require technical innovation. One of the clear lessons of the last ten years, whether the price of energy has been high or low, is that the energy production and supply industries have not invested effectively in new energy-related science or technology. And in the last two years, the first casualties in the oil and gas industries have been exploratory drilling and research of all kinds. Such considerations as these lead to questions about the future role of the Department of Energy and its national laboratories.

Since its establishment in 1978, the Department of Energy has lost its original focus as a research and technology development agency. The additional responsibilities for the regulation of energy prices and distribution and the administration of conservation grant programs and large scale demonstration programs received the lion's share of attention in its early days. In this Administration, justification of a separate cabinet agency for energy has not always been fully accepted. At this point, virtually all of the technology programs that supported the energy mission of the agency have been victims of a philosophical battle between Congress and the Administration. Though the dramatic funding reductions proposed by the Administration have not been completely enacted by the Congress, the uncertainties induced by the process have made long-range planning in these areas impossible and have driven many competent program managers into other agencies or out of the Civil Service altogether.

In many respects the institutional planning process required of the national laboratories is the only formal programmatically related planning activity that takes place in DOE. At LBL we view the Institutional Plan as a useful way to articulate our internal goals, but the only part of DOE which has been able to respond productively to our proposals has been the Office of Energy Research. In large measure, I believe this is because (1) LBL's proposals in this area have been worthy, and (2) the OER programs have benefited from this Administration's steady commitment to growth in basic research.

The picture painted here is bleak. We know the United States will need new energy supply and end use technologies. The Department of Energy programs do not now have a long range view for the development of those technologies, and the private sector is not doing the job either. The national laboratories have retained their capability to contribute to the energy mission of the Department through their basic research capability and their proposals to develop and build new facilities that serve the university and industrial research community. At LBL we see our future in the continued exploration of fundamental scientific and engineering questions that underlie or might lead to new energy technologies. LBL will not build prototype reactors or clean coal combustors. But it is important to LBL that our basic research be complemented by well-planned energy technology programs that have the commitment of both the executive and legislative branches. The disagreements in these areas and the resulting budgetary and policy uncertainties are the most worrisome aspects of the Laboratory's environment.

Recently the Department has established an Energy R&D Planning Council chaired by the Director of the Office of Energy Research and consisting of all the Assistant Secretaries with energy-related responsibilities. This is a significant step if it is actually implemented. A similar strategic planning activity has been initiated within the defense programs area in DOE in which the national laboratories play significant roles. For the Energy R&D Planning Council to be effective, the Department needs to develop supporting activities that include representatives from both the national laboratories and the energy industries.

Basic Research and Industrial Competitiveness. Since World War II, the federal government's sustained commitment to research and development programs has been based on a firm belief in their contributions to the public good. Subsequent economic studies have also suggested that a nation that invests in long-term research maintains the competitiveness of its industries through innovations in more efficient production or new product development. Over the last fifteen years, numerous voices from the public and private sectors have been raised in concern over the lack of investment in research by the nation's technology-based manufacturing industries. As part of solving this problem, the government laboratories have been seen as resources for new technology development and basic research spin-offs that could and should be utilized to support the competitiveness of threatened industries.

The Congress has acted to facilitate these interactions on many fronts: the creation of the Federal Laboratory Consortium, requirements for documentation of technology transfer activities by individual government laboratories and by federal research agencies, relaxed rules regarding contractor ownership of patents and receipt of royalties, and encouragement of consulting by Laboratory employees. The message to the national laboratories has been loud and clear.

LBL has taken action in a number of ways. In 1983, the Center for Advanced Materials was established to undertake basic research directed toward industry needs with a relatively short time frame (five to fifteen years). The Center was intended to create a unique environment where university, national laboratory and industrial scientists could combine their special talents and perspectives to improve the technology base available to industry. Each program in the Center has been developed with the guidance and review of a program advisory committee. These committees are composed primarily of scientists from industry, who have a clear idea about industry's technological needs and understand the contributions that basic research can make.

In conjunction with the Department of Energy's Technology Exchange Program, CAM has initiated Industry Fellowships in three program areas. A local company, Catalytica Associates in Palo Alto, has assigned a project leader to work in the CAM Catalysis and Surface Science Program. He will work with CAM scientists applying scanning tunneling microscopy to evaluate novel techniques for the plasma deposition of catalytic materials. In a second project, the manager of Package and Reliability Fundamentals at Intel Corporation has begun working with the CAM Ceramic and Metal Interfaces Program. He is studying the electrical and mechanical integrity of wire bonds that connect semiconductor chips to control and display devices. The third Fellow is a senior physicist at Exxon Research and Engineering Company. He is working in the Instrumentation for Surface Science Program to develop new techniques to study monolayers of surfactants on liquids. We are in the final stages of negotiations with a fourth senior research and development scientist at Union Carbide Corporation who will be working in CAM's Polymers Program. He is particularly interested in the study of polymer molecules in melted states and their interactions with metallic surfaces of molds and dies, in an effort to understand and therefore control the microstructure of polymer products that determines their properties.

In the short time since its creation, there are a number of CAM's accomplishments that may contribute to industrial competitiveness. Recent tests by scientists in the Structural Materials Program have shown that a new lithium-aluminum alloy (2090-T81, manufactured by Alcoa) has superior strength and toughness compared to aluminum alloys currently used for cryogenic applications. This alloy is being studied in collaboration with U.S. industry, and may be seriously considered for cryogenic fuel tanks. In a second area, significant advances have been made to understand how atomic arrangements determine the images that are produced in scanning tunneling microscopes. These new microscopes, developed initially at industrial laboratories, produce images of atoms on a surface. CAM scientists have developed an electron structure theory that helps to explain the shape of these images, making these microscopes more powerful scientific tools. IBM is helping to support this research through a student fellowship. Both of these accomplishments demonstrate the value of CAM research in sustaining technological innovation in U.S. industrial research and manufacturing. In addition, they both represent projects where industrial funds are an important infusion into CAM programs, estimated to be $400,000, or 10% of CAM's budget in FY 1987.

LBL is also engaged in transferring its accomplishments and technology in biomedical research to the private sector, both in diagnosis and treatment of disease. The Laboratory has developed the highest resolution Positron Emission Tomograph in the world, which is capable of studying central nervous system chemistry with a resolution of two millimeters. In collaboration with IBM, LBL is also developing software for use in Magnetic Resonance Imaging. Both of these advanced instruments are being used to study Alzheimer's disease and schizophrenia. LBL has also investigated the treatment of several types of cancer and arteriovenous malformations in the brain using accelerated beams of protons and helium nuclei.

The Laboratory's research program on energy efficiency in fluorescent lamps has had an important impact in accelerating the transfer of technology from the workbench to the market place. This program was instrumental in assisting the commercial success of U.S. companies in the manufacture and marketing of solid-state high-frequency fluorescent ballasts earlier this decade. At the present time, two LBL lighting projects are especially noteworthy. One has resulted in an efficient fluorescent lamp and ballast system for the U.S. Navy. In collaboration with U.S. industry, LBL developed the performance specification for the lamps and the design specification for the ballast, which were then manufactured by private companies. LBL's testing program demonstrated the systems performance, which will reduce on-board lighting power demand by 30% and lower electrical interference that has been a problem on Navy ships. A second example is the development of new fluorescent lamps with isotopically enriched mercury. This program, conducted in close collaboration with GTE-Sylvania, has successfully fabricated and demonstrated high-efficiency lamps and is currently investigating methods of enriching the mercury for economical lamp manufacture.

Since 1984, LBL has been the recipient of six IR-100 awards from the Industrial Research Institute. These awards are a recognition of the Laboratory's innovations that have resulted in new technical products. These innovations include an automated seismic processor that has applications for the petroleum industry, a silicon detector x-ray spectrometer used commercially for chemical analysis, a high-current ion source that is potentially useful for ion implantation by the semiconductor industry, a high-current neutral beam source now manufactured by industry for the fusion energy program, an ultra-sensitive detector for x- and gamma rays for measuring specific radioactive materials in a range of substances such as soils and lung tissue, and a long-pulse density probe that may have applications for monitoring plasmas used to etch semiconductors. These products are the outcome of basic and applied research in national laboratories. Such research can have commercially important spinoffs only indirectly related to the initial research program goals.

Research on new high-temperature superconductors has the potential for technological advances that may have significant impact on the economy. Advances in this field at university, industry and national laboratories are taking place on a daily basis. At LBL we have assembled a team that is conducting research in four related areas: the theory underlying these new materials, their synthesis using several techniques, their detailed characterization, and their potential application in instruments that may use Josephson junctions. As I will discuss later, this research is a new initiative at the Laboratory, and is built on a research area where the Department of Energy has had a continuing role. The research offers the potential for highly efficient transmission of electricity, wider use of superconducting magnets in such fields as physics and medicine, new high speed train technology, and new computer and instrumentation technology.

Another important key to sustaining technological innovation in industry is highly qualified, well-trained scientists and engineers. In addition to its well-established role in graduate education, LBL is actively engaged in the Department of Energy's science education programs, and is establishing a Science and Engineering Education Center to coordinate activities for college science majors as well as precollege students and science teachers. This summer, for example, the Laboratory will host outstanding high school seniors from the fifty states, the District of Columbia, Puerto Rico, Canada, France, Great Britain, Italy, Japan, and West Germany. They will participate in a honors program in life science research at LBL. This enriching experience will expose these students to a range of biological research, including that related to medicine and biotechnology. In addition, the Laboratory will be conducting summer programs for secondary school teachers, for other high school students and for undergraduates and graduate students in science education.

As indicated by its mission, LBL is committed to developing innovative ways to collaborate with industry. We are convinced that we can contribute to maintaining America's competitiveness in the world market. However, I would like to add a cautionary word about unrealistic expectations for a quick payoff. The original partnership forged between the national laboratories and the Atomic Energy Commission was based on a cooperative approach to the formulation of the agency's R&D policy as well as its implementation. Industry was included but most often was seen as the recipient of technologies and scientific results fully packaged by the government and its laboratories. When ERDA and then DOE were created, the need to include industry as an equal partner in this process was recognized by the organizing legislation. This was necessitated by the primary role that industry already played in oil, gas, coal and electric power production. Reduction of industrial energy demand could only be accomplished if the consuming industries played an active role.

However, new cooperative mechanisms between industry, the national laboratories and the DOE civil servants have been very slow in developing, and the fault lies with all parties. It has been hard to change the federal and DOE patent and procurement regulations that assume either a paternalistic or a paranoid attitude towards cooperation between industry and the laboratories. Industry has viewed the laboratories as protected institutions with little connection to the real world and the "bottom line." They were seen as unfair competitors for the federal dollar or as semi-academic institutions with no connection to technological innovation. The laboratories, in turn, have been slow in realizing that their environment has changed and that new connections are necessary.

Not to speak for the other members of this triad, but for the laboratories, at least, a major change in culture has been required to adjust to these new demands for economic relevance and productivity. It is not a simple thing that is being asked. Even an industry like AT&T with its impressive Bell Laboratories is having a hard time turning their outstanding science into competitive products. I am not asking for patience; the laboratories need to be pushed and they need to continue pushing themselves. But I am asking for a realistic understanding of the difficulty that we all face.

Scientific and Engineering Facilities: The Heart of National Laboratories

The DOE laboratories' strength has been the ability to apply multidisciplinary teams of scientists and engineers towards the development and implementation of nationally important scientific and technical programs. In particular, this strength has been exhibited most impressively when the laboratories have been responsible for the research, design, construction and operation of large research facilities and unique combinations of specialized instrumentation. Many of these facilities were operated for specific technology-development programs and were used by the laboratory staff and other government contractors hired by the national programs. The High Energy and Nuclear Physics programs have been different. The laboratories serving these programs have been operated for a primarily university-based community and, in large measure, have been planned for and governed by that community.

For all of these laboratories, it is the combination of large research facilities, instrumentation, and the underlying basic research and engineering activities that make them special resources for the nation. The future of the laboratories, then, must continue to include the development and operation of nationally significant large research facilities. At LBL, our Institutional Plan places high priority on new facilities because we see them as foci for maintaining our tradition of participation in national programs and for sustaining the creativity of our scientists and engineers. In one way or another, the institutional plans of other OER laboratories recognize the importance of large research facilities.

For this reason, the Scientific Facilities Initiative proposed by the Office of Energy Research is particularly important to the OER laboratories. Not only will these facilities maintain vitality in the laboratory system, but more importantly, they will also create new opportunities for collaboration between national laboratory scientists and the university and industry communities.

Before leaving the topic of facilities, I would like to discuss how critically important the Multiprogram Energy Laboratory Facilities Support (MEL-FS) program is to all the laboratories. As you know, almost all the laboratories are forty or more years old. The utilities, roadways, roofs, engineering and materiel support structures are generally twenty to forty years old. While it is of prime importance to build new facilities that meet DOE program goals, it is important not to forget the more prosaic facilities that make the exciting ones possible. Scientifically effective and efficient use of new national user facilities is interdependent with the maintenance and rehabilitation of supporting facilities. The Department has taken on a new commitment to the concept of the MEL-FS program and maintenance activities. This is highly commendable and appreciated. However, it is important to note that the funding for the program has been slowly decreasing, and it means that the laboratories are falling even further behind. The attention and support of the Congress could be very effective in this area.

Lawrence Berkeley Laboratory's Scientific Initiatives

Having spent a great deal of time on the economic and political constraints facing the Laboratory, let me turn your attention to the really enjoyable part of my job—science! This is a very exciting time to be a scientist. Wherever you look—superconducting materials, supernovae and astrophysics, seismology and earth sciences, quantum chromodynamics and high energy physics, the human genome and molecular biology—exciting things are happening that may change our daily lives as well as the fundamental explanations of why the world works as it does.

The Laboratory's Institutional Plan presents scientific initiatives that combine the excitement of the new science with the Laboratory's strengths and the goals of the Department of Energy's national programs. For FY 1988, the largest scientific initiatives are in the Basic Energy Sciences, with other important but smaller new programs in the General Sciences and in Health and Environmental Research.

The 1-2 GeV Synchrotron Radiation Source, which we call the Advanced Light Source or ALS, is a third-generation electron storage ring that will provide ultraviolet and soft x-ray radiation from magnetic insertion devices. Investigators from industry, universities and national laboratories will have access to unique and powerful research capabilities—coherent laser-like radiation with high spectral brilliance and very short pulse length (tens of picoseconds). When fully developed, the facility will support up to sixty user stations for research in the life sciences, materials science, chemistry, physics and other fields.

LBL is currently engaged in Title I design of the ALS as Congress has authorized for FY 1987. During FY 1988, planned construction activities include preparation of the site, relocation of existing equipment, and procurement of conventional facilities, including architectural, engineering and construction contractors. In addition, fabrication and procurement of the injector system will begin, and the design of insertion devices and beam lines will be further refined.

Important future project milestones are completion of the conventional facilities in FY 1989, completion of the injector and storage ring installation in

FY 1990, insertion device and beam line installation in FY 1991, and project completion in FY 1992.

Materials research conducted with close industry collaboration is emphasized at the Center for Advanced Materials (CAM), which was established in 1984. Now a part of the Materials and Chemical Sciences Division, CAM programs bring together university, industry and LBL investigators to attack materials problems of mutual national concern. As an example, scientists in CAM's Electronic Materials Program and LBL management are working with representatives of the semiconductor industry and the National Academy of Sciences to further the effective utilization of unique national laboratory facilities that can support the competitiveness of the U.S. electronics industry. CAM scientists are characterizing the purity of semiconductor materials such as gallium arsenide which can lead to the development of high-speed, radiation-resistant microelectronic circuitry.

LBL's materials research programs are founded on research accomplishments that include, for example, development of the most sensitive semiconductor and superconducting radiation detectors in the world. These detector development principles have been applied in the revolutionary Infrared Astronomical Satellite that greatly contributed to our space program several years ago, and are increasing the understanding of the structure of our galaxy and the universe. Related programs have contributed to the development of highly sensitive magnetic and electrical field detectors that now are used by the geophysics industry to elucidate the subsurface structure of the Earth's crust.

LBL has also lead the development of heavy-ion nuclear physics as a scientific discipline. This field has brought a more complete understanding of the properties and evolution of matter. Recent experiments at LBL have contributed towards the determination of the equation of state of nuclear matter so that scientists can understand the degree of compressibility of nuclear matter under conditions of high temperature and pressure. The use of accelerated beams of heavy ions is also achieving practical spinoffs for cancer treatment, defining the health risks of space exploration, and developing radiation-hardened electronic circuitry.

Continued research advances utilizing intermediate-energy heavy-ion beams requires rehabilitation of LBL's unique accelerator, the Bevalac. LBL has proposed an upgrade for the existing Bevalac, which will provide a cost-effective solution for meeting research needs for intermediate-energy heavy-ion physics. The Bevalac Upgrade would increase beam intensity by a factor of 100 to 1000 over current intensity, improve control systems for simultaneous operation of many experiments, and utilize the existing injector systems and experimental areas. We are currently working with the Department of Energy and its scientific advisory committees to further define the role of the Bevalac Upgrade and its position in the Long Range Plan for Nuclear Physics Research.

LBL is also pursuing fundamental research projects that have potential for significantly contributing to long-term energy supply. The Laboratory's exploratory research program on Heavy Ion Fusion Accelerator Research or HIFAR has been quite promising. This Subcommittee heard about this program on February 25 from Dr. Klaus Berkner, our Associate Director for Accelerator and Fusion Research. HIFAR is a nationally planned program to explore the use of heavy-ion beam pulses to heat and compress a deuterium pellet to initiate a fusion reaction. Using heavy ions has the potential advantages over other methods of efficiently transferring energy to the pellet for ignition of sustaining a high pulse repetition rate, and of igniting a plasma at some distance from the reactor walls to reduce the neutron flux.

Our initial research has been encouraging as we have demonstrated the ability to transport and maintain a quality beam. The current experimental program for accelerating and compressing four parallel beams has also been successful and is on schedule. The next step, called the Induction Linac System Experiment or ILSE, will be critical to determining the feasibility of the entire accelerator system, including bending and focusing sixteen beams on a target. We are hopeful that the Department of Energy will approve funding of ILSE in the FY 1989 Budget. If so, the experiment using ILSE would be completed in the mid-1990s, providing the Department of Energy and Congress with the necessary information to decide any next steps in a Heavy Ion Fusion Program.

The development of high-temperature superconducting materials is also a very promising energy-conserving technology for the nation. Recent developments indicate that these materials may operate at liquid nitrogen temperatures or higher. This would enable new superconductor applications such as zero-loss transmission lines, wider use of high field magnets, lower cost medical diagnosis, faster and smaller computers, and efficient high speed trains. At LBL we have contributed to the theory, synthesis, characterization and instrument applications of advanced superconducting materials, and we look forward to sustaining and advancing the DOE superconductivity research program that has been instrumental in maintaining this nation at the forefront of superconducting materials research.

While we are pursuing energy research in physics and materials science, our programs in chemistry offer new understanding of chemical reactions that ultimately control how combustion engines operate and how the environment is affected by exhaust gases. The Lawrence Berkeley Laboratory is understandably proud of the Nobel Prize in Chemistry awarded this past winter to Yuan T. Lee. Professor Lee's research has been supported by the Department of Energy at LBL since 1974. He has developed advanced instrumentation based on colliding beams of molecules to determine how the electron orbitals of individual atoms in a molecule interact during chemical reactions such as fuel combustion. This area of chemistry, termed reaction dynamics, has been identified as an important frontier in science by the National Academy of Science in its recent report "Opportunities in Chemistry." LBL and Professor Lee are working with the Department of Energy to further push this scientific frontier through the development of advanced laboratory facilities using photon sources such as lasers and the Advanced Light Source.

LBL has also maintained a strong health and environmental research program since the 1930s. Based on our current research in cellular and molecular studies of carcinogenesis, mutagenesis and DNA research, we are proposing a Human Genome Center, focusing primarily on creating a physical map of genes in human chromosomes. This Center would be a part of a nationwide human genome research program proposed by the Department of Energy in its FY 1988 Budget. The LBL Center would include a computer data bank for compiling the genetic map, a library of cell clones and cell lines, and a basic research component directed to improving mapping techniques and utilizing the accumulated data for the medical community.

This proposed Center has created a great deal of excitement in the scientific community, and promises to be an important foundation for understanding hereditary illnesses and environmentally caused diseases, and for ultimately controlling many disease processes.

Conclusions

I would like to conclude my testimony with a few simple statements, which summarize the major points.

o At the Lawrence Berkeley Laboratory, we realize that the Department of Energy has and will have limited resources for some time. The Laboratory's new scientific initiatives have been developed to maximize the Laboratory's contributions to important national programs now and in the future within a constrained federal budget.

o Today's weak dollar and low oil prices have made it politically attractive to ignore the coming decline in domestic oil and gas production and the concomitant increasing dependence on imported oil. Technical alternatives for oil-consuming technologies and improved means of exploration and production of domestic oil and gas supplies must be supported now. One of the clear lessons of the last ten years, whether the price of energy has been high or low, is that the energy production and supply industries have not invested effectively in new energy-related science or technology.

o The DOE institutional planning process has been an important tool for LBL's internal planning. DOE's Office of Energy Research, especially through its Scientific Facilities Initiative, has been the most responsive organization within DOE to laboratory planning. A broader DOE energy R&D planning effort is needed into which the laboratories and industry are integrated for matters of both policy and implementation.

o Basic research performed by and at national laboratories can make a strong contribution to economic competitiveness. At LBL, we have made significant efforts to organize research programs that involve both the guidance and participation of industrial scientists. Our involvement with graduate education in areas of science relevant to industrial interests also meets national goals to improve competitiveness.

- Large scientific and engineering facilities—their development, design, construction and operation—are among the most important contributions that national laboratories can make to national efforts in research and technology development.

- Science today is lively and exciting. The need for science-based innovation in energy-related industries and others is clear and in some cases obvious. LBL's proposed initiatives for the future are aimed at these opportunities that will serve the scientific needs of broad segments of the scientific community.

Madam Chairman, I am pleased to have had the opportunity to address you today. I believe that the Congress and this Subcommittee can and should play an important role in guiding the future of DOE's efforts in energy research and development. I hope my comments will be of some assistance. Thank you.

PANEL DISCUSSION 2

Mr. CHAPMAN. Thank you very much, Dr. Shirley. I will be again, if I may, asking a couple of questions directed to you, and first perhaps a comment. The committee appreciates the funding breakdown that is contained in the prepared comments that you have on page 2, and the gentlelady from Tennessee has requested perhaps that it might be beneficial if the other directors might furnish for purposes of the record a similar breakdown of the funding history and projected funding in the various program areas.

First let me ask you, Dr. Shirley, what percentage of your budget can be attributed to reimbursable funds from sources other than the Department of Energy, or perhaps other than the Federal Government itself.

Dr. SHIRLEY. The figure with respect to sources other than the Department of Energy is just under 20 percent of our funding comes from other sources. Most of these, however, are other Federal sources such as the National Institutes of Health and other Federal agencies. The extent of non-Federal sources is a number that I would like to check out and provide a detailed answer for the record, but it is certainly under 5 percent of our total support.

[The information follows:]

For FY 1987, LBL expects to receive $5.7 million, or approximately 3 percent of our total budget, from non-Federal sources. This percentage is expected to remain constant in the coming years.

Mr. CHAPMAN. Your views on the planning process as performed by the laboratories and interpreted by the Department of Energy is a little different than some of the other witnesses have stated. And you seem to verbalize concern that the committee has had for sometime; that is, there simply may not be a clear connection between institutional planning as performed by the laboratories, reflecting their own personal capabilities and visions, and how these institutional plans are incorporated within the overall DOE strategies associated with energy R&D.

What, in your view, needs to be done to correct this situation? And I am thinking here specifically of whether or not this committee could play any role in that or the Congress should play any role in that process.

Dr. SHIRLEY. Mr. Chairman, the institutional planning process has been utilized quite effectively within the Office of Energy Research, which is of course only one portion of the DOE program. However, we have recently learned that the Under Secretary has announced the formation of an energy R&D planning council which will be chaired by the Director of the Office of Energy Research and will have representatives from other Department of Energy programs.

We applaud this. We think it is a good step and we would recommend that the committee should be aware of the activities of this planning council and follow as appropriate in their deliberations.

Mr. CHAPMAN. Let me ask you to comment, if you would, on— using that announcement as sort of a take-off point, if the appointment of that planning council and its formation, if the budget recommendations, in fact if the Federal budget for R&D in this area reflects a serious, if you will, about implementing any recommendations of that council.

And I am specifically seeing reflected, at least in my opinion, as to the cuts that we see in this area, that it is fine to appoint a council, and then if we cut funding to such an extent we jeopardize, in fact, so much of the good work that all of you have done in your areas by not having the money to implement the recommendations that such a council might make.

Do you have any comments on that?

Dr. SHIRLEY. Well, Mr. Chairman, I think it is fair to say, on behalf of the representatives of other national laboratories as well as myself, that we do sense a need for a coherent and broad long-term energy research planning process within the Department of Energy which would extend outside of the Office of Energy Research.

We believe, or at least speaking for myself, I believe that there are many opportunities and needs in the energy technology areas that could be more broadly addressed by the Department of Energy.

Mr. CHAPMAN. After an examination of your testimony, I think the subcommittee can only be impressed by the level of accomplishments that you describe by the Center for Advanced Materials. I am, however, concerned about the accomplishments in the area of sophisticated technological and scientific innovations.

What is actually being done to solve the basic problem of getting those innovations into the marketplace with products that are competitive not only in the domestic markets but also internationally?

Dr. SHIRLEY. Mr. Chairman, there are a number of models that have been developed for effecting technology transfer from a research laboratory into the marketplace. I believe the lesson that we feel that we have learned, and I think some of the other laboratory directors would concur, is that this process has to be carried out at a very early stage. You must have representatives from industry who are involved in laboratory programs, who visit the laboratories, who work at the laboratories on assignment and so forth to become familiar with the early steps in the research and to help to set the research agenda for the laboratories.

This is the tack that we have taken in the Center for Advanced Materials. We do bring industrial fellows in, for example, to work with our people. There is a Department of Energy program to do just that, as a matter of fact, which extends across all the laboratories. It is still a small program. It involves some 20 people this year.

The Center for Advanced Materials will have workshops, does have workshops, which takes industrial input to help formulate problems at the early stage. So I think the key words here or the key ideas are to have intimate involvement by industry at the early state of development of a new technological breakthrough.

Mr. CHAPMAN. Let me ask if anyone else, if any of the other directors have any comments on that as it may apply to your particular laboratories?

Dr. SAMIOS. I will make a brief comment. I try to show at the Light Source one third of the people on the floor are from industry, and they have kicked in $10 million putting equipment on the floor. In doing research at a forefront facility, we believe, alongside with our scientists and other people, they will develop new things.

For instance, IBM set up an x-ray lithography booth right on the floor. They tested out the ideas, and I think that is why they are very enthusiastic about having a factory or they are convinced x-ray lithography is the way to go to megabit chips.

So the existence of the facility, IBM scientists working on the facility for several years proving out their ideas, I think, is an ideal way of getting technology transfer.

Mr. CHAPMAN. And you are satisfied that that is working, from the standpoint particularly from our side? Is there anything that you can see other than the programs which you suggest here, obviously? You are in a much better position than we to——

Dr. SAMIOS. I commented earlier there are a few test cases that are coming up, x-ray lithography being transferred to industry. I commented earlier that that seems to be a national need. I think that will be a test case, whether we do it. Dr. Schriesheim mentioned also how do we do with this new revolution in superconducting materials. It is really great. How does it get transferred to industry, how do we make progress in this area?

Dr. WILEY. Mr. Chairman, I just wanted to mention that we have a unique arrangement at the Pacific Northwest Laboratory in that we have a private use permit which permits us to use the Government facilities as well as our facilities in a consolidated laboratory concept. This puts us in touch with industry on our private research side, which is a kind of a technology development role that we play and Battelle has played throughout history.

So that one of the things that we have found to be very useful is having that interaction with industry up front and having the opportunity to provide industry with a proprietary project such that the work that we do for them, they pay for, and it gives them a proprietary position. So that is a very important thing, I think, in the whole process.

Mr. CHAPMAN. Dr. Zucker.

Dr. ZUCKER. Mr. Chapman, there are a couple of things, I think, that would be helpful and I think the Congress could help in. I think it would be useful if in some way the national laboratories were given the explicit mission of transferring technology, doing research and essentially being an ally of industry in this whole competitiveness issue. It would cost nothing, but I think it would legitimize what all of us, I think, feel is an important mission of the laboratories. I think you will probably hear from all of us that we are capable of doing it.

The second point has to do with cost. The laboratories usually carry their research out to a certain point where they prove a principle or discover some property or something like that. Industry can't take that material and market it. There is a whole development program that has to intervene. There is currently no money, no funding for that kind of thing.

In the days of development of nuclear energy, there used to be a specific fund that was there to bridge that gap. I think some attention needs to be paid to that. Who pays for that development, who pays for that intermediate step? Industry is not willing to do it.

They think the risk is too high. We have no funds with which to do it.

Finally, the whole question of an industry-laboratory alliance needs nurturing, and any source of nurturing is welcome. I think, again, here the Congress could play a role in catalyzing a rapprochement between industry and the national laboratories simply by giving it more visibility, by insisting that both industry and the Department not only pay lip service but actually contribute resources to it.

Mr. CHAPMAN. Thank you, sir.

Dr. Schriesheim, the Advanced Photon Source is clearly a critical new initiative in your laboratory. Was it only funding limitations that precluded commencing construction activities in fiscal year 1988 rather than fiscal year 1989?

Dr. SCHRIESHEIM. We could commence construction in fiscal year 1988 at a level such that the Photon Source would be finished probably a year earlier than if we started in 1989. We would initiate construction on conventional facilities. It would put us in a position so that the lab would be certainly in a position such that it would be finished earlier than if we started in 1989. I think that is the best way to answer that question. Certainly we could start in 1988.

Mr. CHAPMAN. Let me just toss a question out to you gentlemen, and I am going to be geographical here, if I may. I am from Texas. I will ask you if within the various laboratories you represent and the work you are doing, if anyone is in a position to make a prognosis as to basic research in the area of liquid hydrocarbons, enhanced oil recovery, within the purview of doing basic research that would increase our ability to produce oil and gas that is now unrecoverable under current technology?

If any one of you would care to, I would like to hear someone comment on what we could do in the Congress or what type of leadership perhaps we could provide to enhance that research in the second part of that question, if you would care to comment on whether or not that type of basic research and development of those technologies is likely to lead us to the ability to recover a lot more of those minerals than we have now, or that product than we have now?

Dr. SCHRIESHEIM. Well, Mr. Chairman, let me take a crack at that.

I spent a goodly number of years in the oil industry. I ran the research—large research programs at Exxon Corporation before I took my current assignment.

The fact of economic life today, certainly, is that the major energy companies that have sophisticated research programs do not have, in the main, large amounts of money going into long-range, high-risk research. The Government has really become the funder of last resort, and I don't think you'll get an argument on that from many people.

There is little doubt that considerable hydrocarbon reserves remain in wells that currently exist, in strata that can be recovered, at a price, depending on the price of crude. So the thrust is to uncover the technology that will lower the cost of secondary and tertiary recovery.

Having looked at that for years, I believe that that's possible, given the research programs, the dollars flowing into the research programs—geochemistry, geophysics, multiphase flow, the uncovering of surface-active agents that will be more effective in releasing oil from the strata underground.

And I don't think there's any serious debate that additional dollars flowing into that area will—that additional dollars flowing into that area will produce additional hydrocarbons at a price.

Now coming from the science and technology community, I'm being an optimist by nature. I like to assume that that kind of an investment will lead to technological breakthroughs that will pay off for the country.

Mr. CHAPMAN. What role—let me follow up and ask, what role, if any, the national labs perhaps play in doing that kind—if this committee should authorize an increased commitment to that research, what role would the national labs play in that?

Now, Dr. Zucker, you had your hand up. I'd ask you if you would comment on that. Or is that something that you—if we authorized the funds, you would just give it to DOE and let DOE decide where to spend it?

I'm real troubled by the commitment I see, at least in this particular area, of this Administration. I think it goes one step beyond gross negligence. But understanding that's where I'm coming from, I'd like to hear your comments.

Dr. ZUCKER. Well, Mr. Chapman, you sound like a great voice from the past to me. We had a program in place that I believe did help oil recovery and gas recovery, secondary and tertiary recovery, and now that oil is reasonably plentiful, that's, of course, gone. But the days of that are numbered, and I'm really very pleased that you raise this issue again.

I believe the national laboratories could contribute significantly in areas that Dr. Schriesheim mentioned, in research on surfactants and pushers, the ways to get the oil from tight formations out to where it can come out of the well.

I have hoped that one could learn more about deep gas. I'm sure you know the magic of deep gas. If it's there, there's an awful lot of it, and some of the estimates are really mindboggling. And I think we owe it to ourselves to find out.

So I think the National Laboratories, at least Oak Ridge National Laboratory, and I suspect Argonne as well, would welcome such resources in the geochemistry and geology and in the chemistry of oil and gas.

We would not, at this time, like to get between you and the Department of Energy on how that is decided.

Mr. CHAPMAN. Gentlemen, let me, on behalf of the entire subcommittee—hold it. I thought I was about to be able to excuse you, but the real Congressman Morrison is here now.

Mr. MORRISON. Thank you.

Mr. CHAPMAN. And let me turn it over to him for questions.

Mr. MORRISON. Thank you, Mr. Chairman. I apologize. We've got a bill going on the floor, too, that relates a little more to the world of the political, with the Surface Transportation Act.

I just wanted to ask one question. I know you've been here now in front of this panel almost for three hours, and that's certainly more than enough.

I just wanted to share with you how much I've appreciated all of your testimony—I've read it all and will be referring to it again—and repeat my opening statement of how proud we are of the national laboratories and the job you're doing for America.

I did want to ask Bill Wiley one question. I notice in your testimony, Dr. Wiley, you indicate that you're sort of behind the rest of the laboratories as far as some of the new facilities priorities are concerned and noticed that there is no mention at all of facilities spending in PNL's budget request.

Is this standard procedure, as far as you're concerned, and do you foresee opportunities ahead where we will need to look at facilities?

Mr. **Wiley**. I see, Congressman, that we will have to look for new facilities. I don't know whether you know this or not, but we have, since 1965, there's been one facility constructed at PNL. So it's a whole series of difficult problems that have resulted in the situation we find ourselves.

The molecular sciences initiative is a facilities initiative and would result in a user facility which we hope will receive favorable response from the Department of Energy in this year's budgeting cycle.

Mr. **Morrison**. Thank you. We'll be looking for it. And thanks to all of you gentlemen. We appreciate it.

Thank you, Mr. Chairman.

Mr. **Chapman**. Let me just say thanks to all of you. I apologize for my tardy arrival. I have an interest in the same legislation on the floor that my colleague does. And we appreciate the good work you do, and I speak for the chairman of the committee in thanking you for your time here today.

The subcommittee will reconvene at 9:30 tomorrow morning in Room 2325 to review DOE's budget request for nuclear waste, and the subcommittee now stands in adjournment.

Thank you, gentlemen.

[Whereupon, at 3:53 p.m., the hearing was adjourned.]

[Questions and answers for the record follow:]

RESPONSES TO HEARING QUESTIONS

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

March 18, 1987

Alexander Zucker

Oak Ridge National Laboratory

Question 1. One of our earlier witnesses, Dr. Robert Hansen, Director of Ames Laboratory, testified that he perceived that the DOE now has a facilities focus rather than an energy focus. Do you believe this to be the case, and if so, do you think this change in focus is appropriate?

For a variety of reasons the Department of Energy is the builder and operator of most of the large scientific facilities in this country. DOE has proved its ability to carry out large scientific ventures and to operate them efficiently and economically. I do not believe that this means that DOE research has lost its energy focus, but the fact is that the urgency of applied energy research has lessened considerably in the popular perception since the 1970's.

Question 2. The December 1985 Energy Research Advisory Board report on "Guidelines for DOE Long Term Civilian Research and Development" recommended that the BES budget should establish a "separate budget category for facilities construction and operation". Do you agree with this recommendation?

A separate budget category for facilities construction and operation would in my view reduce the flexibility of the BES operation and therefore decrease its effectiveness.

Question 3. As you know, the President has proposed constructing the multibillion dollar Superconducting Super Collider (SSC).

a. What is your view of the project?

The Superconducting Super Collider is an important project for this Nation and for elementary particle physics.

b. What impact might it have on funding for other research priorities?

It is, I believe, the policy of the Administration and the Congress that the construction and operation of the Superconducting Super Collider will not impact other research priorities. Should that not be the case, then the whole question of the advisability of building the SSC should be reexamined.

c. If there was clearly a stark choice between additional funding for academic or National Laboratory research, and construction of the SSC, what choice would you advise this Committee to make?

If there were a stark choice between additional funding for academic or National Laboratory research and construction of the SSC, I would suggest a review of the entire subject as well as an accelerated effort to obtain international support for all major facilities including the SSC.

Question 4. The Committee is often confronted by individuals and groups requesting moneys for research proposals and facilities that have not undergone the normal merit review process. How should the Committee treat such requests? What review mechanisms or policies should be implemented to ensure that taxpayer dollars are being well spent?

When the Committee examines requests for funding for research proposals and facilities which have not undergone the merit review process, then I believe the Committee itself acts as a reviewing body. As a minimum it must ask the requester to establish the need for a particular project, describe who will use it and for what, and, in the case of facilities, how they will be supported in the long run. The Committee can then send out documentation, submitted with the request, to its own reviewers to get additional input.

Question 5. What is the level of Work for Others at your Laboratory, and what percentage is this level of your total Laboratory funding?

	Fiscal Year (dollars in millions)				
	1984	1985	1986	1987	1988
Work for Others* (BO)	$ 47.6	$ 74.5	$ 63.6	$ 61.4	$ 70.7
Total Laboratory	$358.8	$398.5	$376.7	$390.1	$422.9
WFO/Total Lab (%)	13.3%	18.7%	16.9%	15.7%	16.7%

*The Nuclear Regulatory Commission funding is specifically excluded from the Work for Others figures as requested by DOE. Work for Others definition based on Institutional Planning instructions.

Question 6. Please comment on the DOE-imposed ceilings regarding the amount of Work for Others at your Laboratory. Is the level too high? Too low?

Current ceilings on the amount of Work for Others at the Oak Ridge National Laboratory are about right. However, they might well change with the needs of the country as conditions change. It seems clear that it is inefficient to place artificial limits on an institution that can make significant contributions to the scientific and technological needs of the country.

Question 7. On January 14, 1987, the Department of Energy promulgated a new regulation (48 CFR Part 970, Acquisition Regulation) prohibiting lobbying by its contractors.

a. Do you believe it is proper for Laboratory management or staff to approach Congressional Members or staff with proposals for additional funding for new or ongoing programs in the absence of a substantive request for such information? What is the policy of your Laboratory in this regard?

b. One provision in this regulation allows contractors to recover costs responding to Congressional inquiries only if written information provided in such response is concurrently furnished to the DOE.

i. Do you believe this will inhibit you in substantiating orally-transmitted information or providing other written information in response to telephone requests by Congressional Members and staff?

ii. What, if any, difficulties, additional costs, etc., do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your Laboratory's additional costs because of this requirement?

c. Another provision of the regulation limits the recovery of contractor costs incurred in providing written information to Congressional staff during oversight visits to the contractor-operated laboratories. Such costs may only be recovered if the contractor provides the information concurrently to the Department of Energy.

i. Do you believe this will inhibit you in providing written information to Congressional staff?

ii. What, if any, difficulties, additional costs, etc., do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your Laboratory's additional costs because of this requirement?

d. What, if any, concerns do you have with any other provisions of the regulation?

Question 8. What use do you make of external review groups, other than DOE groups, in evaluating and monitoring your various research programs?

Research programs in each division at ORNL are evaluated annually by external Advisory Committees comprised of four to six experts in the appropriate fields from universities and industry. Typically, individuals serve on an Advisory Committee for three years. The Advisory Committees usually meet for three days and provide a written report to the Director of the Laboratory that summarizes their findings and suggestions. The division prepares a response to the committee report that includes a discussion of actions resulting from the suggestions. In addition, members of the committee usually visit the division on an individual basis during the course of the year. Occasionally, special external reviews are carried out as deemed necessary by Laboratory Management.

Many National User Facilities are located at ORNL. These facilities have Program Advisory Committees and User Committees to help guide the development and operation of the facility. These committees usually meet annually and provide evaluation and recommendations for new equipment and capabiliities for the facility. User Facilities also host numerous workshops for the User Community. Last year, for example, the Holifield Heavy Ion Research Facility at ORNL hosted four workshops on techniques and technique/equipment development. These provide an additional forum for external input to the program.

Question 9. What are the major institutional issues facing your Laboratory? How are you addressing them?

The major institutional issues facing ORNL are related to the decline in DOE's role as an energy research and development agency. Energy-related research now constitutes less than 20% of what the Department does. Declines have been almost entirely in technology-specific areas. Supporting research areas, such as materials R & D, are being supported very well and are producing excellent results. But one major strength of laboratories like ORNL and Argonne is their ability to organize and focus multidisciplinary talents on major technological developments. It is likely that the Nation will need this capability as energy once again becomes a major issue. Thus, a major challenge for the Laboratory is to come through this period of low support for energy technologies with the skills and facilities intact that are necessary to contribute to future energy R & D projects.

Question 10. The Energy Research Advisory Board (ERAB) recently issued its report "Geoscience Research for Energy Security." Please comment on each of the four principal recommendations of that report:

a. The DOE should modify its policy and give the highest geoscience research priority to shorter-term, lower-risk options for energy supplies upon which the Nation will be primarily dependent for at least the next two decades.

I do not agree with this recommendation. Geoscience research must retain a strong long-term research component. Short-term low-risk research is really the responsibility of the oil companies. As the price of oil and gas increases, the government can insist that the oil companies initiate strong research projects.

b. Establish in the DOE an Office of Geoscience Research to develop and administer a strategic plan for geoscience research activities within the Department, especially in oil and gas and other liquid hydrocarbon conversion options.

c. Establish oil and gas research centers within each of the six major oil and gas provinces of the United States to conduct and coordinate interdisciplinary problem-oriented research in the following areas all of which mitigate the problem of domestic hydrocarbon supply: enhanced oil recovery, unconventional natural gas recovery, subtle petroleum trap exploration, and geological basin analysis.

It seems to me that there are enough DOE laboratories in existence now. The research alluded to here can be carried out by existing laboratories or Energy Research Centers.

d. Increase oil and gas research funding by an initial annual increment of $50 million, primarily to support the regional research centers.

Question 11. Please describe the Strategic Defense Initiative (SDI) efforts you have been and are conducting at your laboratory. What are the actual and estimated SDI funding levels for your laboratory you have received (both DOE and DOD) for each of FY 1987, FY 1987, and FY 1988? [*sic* -FY 1986-1989 data provided.]

The SDI program within Oak Ridge utilizes the special capabilities of all three facilities: ORNL, Y-12, and K-25. Efforts include research on neutral particle beams, lightweight power and energy storage systems, optical components, survivability and shielding, flywheels, electromagnetic rail guns, and lightweight structures utilizing high temperature materials. For example, our work on neutral particle beams has resulted in the continued improvement of negative ion sources having high particle production and low beam divergence.

Several SDI areas related to power and energy storage systems are currently under investigation including steady-state Rankine nuclear system concepts, non-fuel materials, energy storage systems, and thermal energy conversion systems. In addition, expertise and special facilities for mirror fabrication, ion implantation, radiation testing, and optical characterization are being applied to the development of radiation-hardened, passive optical components for SDI. Other research is centered on the development of shields for space-based assets against high-kinetic-energy particles, high energy lasers and particle beams, as well as natural and man-made radiation.

Flywheels potentially provide a very attractive method of storing energy until it is needed and then dumping it in large bursts of tens to hundreds of megawatts. Our experience in centrifuge technology is being applied to these power storage systems.

The extensive materials, coatings, and fabrications expertise developed primarily in the weapons program is being applied to the development of better electromagnetic rail gun components. The lightweight structures program is also based on the extensive expertise developed in the weapons program for the fabrication and testing of high-temperature carbon/carbon composite structures. Other high-strength materials from the weapons program and the centrifuge program are also used.

Other current efforts include (1) high-acceleration testing of electronic components, (2) surveillance technology, and (3) high-speed, supercomputing capabilities.

SDI BUDGET LEVELS (DOD and DOE):

FY 1986 - $13.7 million (actual)
FY 1987 - $15.1 million (projected)
FY 1988 - $26.3 million (projected)
FY 1989 - $26.1 million (projected)

Question 12. What pressing needs of your Laboratory are not addressed adequately in the DOE's FY 1988 budget request? What funding would be necessary in FY 1988 to meet these needs and what will be the consequences if these additional funds are not made available?

As I indicated in my testimony, there are several areas in the DOE FY 1988 budget that fall short of our requirements. One is the need for an additional $6.5 million for the operation and restart of the High Flux Isotope Reactor. Without this additional funding, the Nation would lose its most powerful research reactor and the areas of neutron scattering, isotope production, and materials irradiation would be severely impacted. There would be no facilities for small angle neutron scattering in the U. S., no place in the country in which to irradiate materials for fusion reactor studies, and no place in the country that can produce transplutonium elements for research. Isotope production for medical applications would also be severely impacted.

A second area has to do with the Advanced Neutron Source. If the DOE budgets $3.0 million for FY 1988 instead of the $7.7 million that we need, the Advanced Neutron Source will be delayed by at least two years.

Question 13. You say you "believe there is a strong need for a new Heavy Ion Accelerator in the energy range between present accelerators and RHIC".

a. What is the scientific justification for such a machine?

A primary thrust of the research program on such a facility will be to map out the "nuclear equation of state", the bulk properties of nuclear matter at high densities (several times that of normal nuclear matter) and at temperatures greater than 100 MeV. Only with the high energy, intense, high quality beams possible with the proposed facility can the intricate correlation experiments be carried out that will be required to map out the quantitative features of the "stressed nuclear matter."

Other important areas: Fully stripped ions of nuclei over the entire mass and charge range of stable nuclei will be available to perform extremely precise tests of quantum electrodynamics. High energy projectiles of high Z will be the source of unprecedentedly intense and clean spectra of virtual photons, so much as to possibly redefine the field of photonuclear absorption physics. A new frontier of the nuclear topography for exotic isotopes far from beta-stability will be reached in reaction induced by both primary and secondary beams.

In 1986, a subcommittee of NSAC reviewed this area of physics and found "there is very high scientific merit for a fixed-target facility providing heavy ion beams throughout the Periodic Table with energies to 1 GeV per nucleon and with intensities much greater than those of the existing Bevalac. Such a facility could support a very diverse program of research".

> b. What proposals exist to provide such a device, and if ORNL has such a proposal, please provide the proposed schedule and funding profile through project completion, as well as estimated annual operating, capital equipment, and other general maintenance and upgrade funding requirements.

In the U. S., there are two proposals to provide such a facility. At Oak Ridge, we have proposed a major upgrade to the Holifield Heavy Ion Research Facility which would include a synchrotron accelerator ring and an additional storage/cooler ring. Such a facility would provide for complete exploitation of the physics of this energy region and would be directly competitive with the facility now under construction at Darmstadt, Germany. The cost estimate for the facility is $68.5 million (in present-day dollars) with funding spread over five years. Operating costs are estimated at $11.5 million annually, which would include $5 million redirected from current Holifield operation. An initial experimental equipment budget of $10 million has been estimated, but we have not been requested to develop the proposal to the point where an estimate of continuing equipment and maintenance budgets has been worked out with the potential user community. The Lawrence Berkeley Laboratory has proposed the first phase of such a facility by replacing the existing Bevalac with a modern synchrotron ring. The cost of this upgrade is estimated at $34 million in present-day dollars.

Question 14. Please describe the Advanced Control program, ACTO, mentioned in your testimony? What is the current and proposed funding level of the program?

Modern automated control systems utilize the versatility of digital signal processing, analysis, and communication. These systems can accomplish in an orderly, comprehensive way most of the menial activities of an experienced human operator and perform the procedure and diagnostic analyses that support the operator. The automated control system can perform this function more rapidly, manage more complex systems, and consider more aspects of the situation in a shorter time than can a human operator. The traditional role of the "hands-on" operator can then be elevated to that of a supervisor, planner, and strategist. Using techniques of artificial intelligence, the automated system can absorb and learn from human experience and evaluate resources and optional paths to achieving a control objective, thereby emulating the human skill of the most proficient expert.

The automated control system can incorporate systematically the considerations of control goals and strategies, assessment of present and future plant status, diagnostic evaluation and maintenance planning, and signal and command validation. It has not been feasible to employ these capabilities in conventional hard-wired, analog, control systems. Recent advances in computer-based digital data acquisition systems, process controllers, fiber-optic transmission, artificial intelligence tools and methods, and small, inexpensive, fast, large-capacity computers (with both numeric and symbolic capabilities) have provided many of the necessary ingredients for developing large, practical, automated control systems.

The advantages of automated plant control systems include reduced staff manpower requirements, elimination of human errors in operating plants, improvement of plant availability, ability to manage multimodular plants, reduction of challenges to plant protection systems and to inherent safety features, and reduced risk to plant investment.

The FY 1988 DOE budget request identified $2.6 million for the ACTO Program to support the current DOE advanced LMR program. ACTO capabilities will be available as early as FY 1988 to support the initial phases of LMR control system design. Incremental expansion of the ACTO Program to support automation of other advanced reactor systems (i.e., LWR, HTGR, Research and Production Reactors, Space and Defense Reactors) would be very cost effective. ORNL has suggested adding $2.4 million in FY 1988 to expand the Program to support other advanced concepts as well as the advanced LMR concept.

In the final analysis, the nuclear industry stands to reap enormous benefits in power plant availability, reliability, and safety from the incorporation of automated control technology. We believe the investment in the ACTO Program will be extremely cost effective in performance improvement and in reduction of the unit cost of control systems for future reactors.

Question 15. Please describe the Heavy Ion Storage Ring for Atomic Physics (HISTRAP) you would like to propose for FY 1989.

a. What is the scientific justification for such a device?

The primary motivation for the use of a cooled heavy ion storage ring in atomic physics is the study of multiply charged ions. These are of great interest in both fundamental and applied areas. The intrinsic interest in the multiply charged ion physics stems from the possibility of using simple atomic systems, in which all the forces are known, to test concepts in quantum mechanics and quantum electrodynamics and to test solutions of the many-body problem. Major extrinsic interest arises from the fact that the native habitat of multiply charged ions is in high temperature plasmas, like those found in regions of high energy density such as stellar atmospheres, fusion devices, or explosions. One current area of high interest ties to the energy levels of multicharged ions being widely spaced, giving rise to the possibility of X-ray lasers from these systems. Thus, these applied interests spread over the fields of plasma physics, fusion energy, weapons systems, atmospheric physics, astrophysics, and nuclear physics.

Unfortunately, many of the most interesting and important processes (e.g., those involving electron-ion and ion-ion collisions) have not been available for study because of the limitations on the capabilities of experiments utilizing plasma sources and ion beams. These limitations are removed, however, if the ions are stored in a synchrotron ring.

The HISTRAP is a heavy-ion synchrotron ring which will be able to accelerate or decelerate, and store multiply charged ions. "Cooling" of the ion beam will be accomplished by a merged electron beam contained in the ring. Injection into the ring will come from two sources: the Holifield tandem electrostatic accelerator and/or a dedicated electron cyclotron resonance multicharged-ion source followed by a radiofrequency quadrupole accelerator. Energies up to 88 MeV per nucleon will be attainable for totally stripped light ions with A/Z = 2. Such ions will be of particular interest to the nuclear physics program at the

Holifield and, in conjunction with the sophisticated experimental devices already available, will provide new research opportunities unique in this country. Also, HISTRAP will be able to decelerate ions down to 20 keV per nucleon, while preserving good emittance via electron cooling, for special classes of atomic physics experiments. Facilities with such capabilities are under construction in six laboratories in Europe and two in Japan, but HISTRAP would be the only such facility in the U. S. Associated with the Holifield Facility, it will be the most powerful of all such facilities. We believe that HISTRAP is a facility much needed by this country.

b. Please provide the proposed schedule and funding profile through project completion, as well as estimated annual operating, capital equipment, and other general maintenance and upgrade funding requirements.

Oak Ridge National Laboratory has proposed HISTRAP as an FY 1989 construction project. As an addition to the Holifield Facility, this proposed synchrotron/cooler ring would capitalize on the availability of the world's best source of high-quality, high-energy, heavy ions for an injector. The cost of HISTRAP, escalated to real-year dollars, is $14.6 million, with a four-year funding profile ($1.5, $6.8, $3.2, $3.1 million). Projected annual operating costs for HISTRAP are $740,000 with $300,000 of this reprogrammed from closing of the EN tandem Van de Graaff. Capital equipment costs are projected at $250,000 per year with about half of this funding dedicated to general maintenance and upgrade requirements.

Question 16. What isotopes are or will be either in short supply or unavailable domestically as a result of the shutdown of the High Flux Isotope Reactor (HFIR)? What alternatives exist to produce these isotopes in the U. S.?

Twenty-five isotopes are or will be in short supply or unavailable domestically as a result of the shutdown of the HFIR. Alternate production facilities currently being evaluated or used are the Advanced Test Reactor (ATR) in Idaho, the Fast Flux Test Facility (FFTF) in Washington, Brookhaven National Laboratory (BNL), the University of Missouri, and Massachusetts Institute of Technology (MIT).

It should be noted that operation schedules at these reactors are dictated by other programs and are not optimized for isotope production. In addition, production rates at any given reactor are slower than HFIR, which will require that some isotopes be produced at more than one reactor. Finally, with the off-site reactors, irradiated targets must be shipped to ORNL for processing of most of these isotopes.

Question 17. What is the impact of the HFIR shutdown on the budget requirements of HFIR and the Transuranium Processing Plant (TPP)? Will less funding be required in FY 1987 and FY 1988 if HFIR remains closed, and if not, why not?

Because of the importance of HFIR to DOE's research and isotopic production programs, we have been aggressively conducting an essential program to restart the HFIR. While there has been less expense for operation of HFIR, the increased activity associated with assessing the condition of the reactor and preparing for restart has increased the budget requirements for HFIR in FY 1987 by approximately $4 million relative to the original estimate for FY 1987.

We do not anticipate that HFIR will remain closed in FY 1988. Our plans now are to restart the reactor in the Fall of this year. Our estimate of budget requirements for FY 1988 if it is restarted is $18.5 million. If HFIR should remain closed in FY 1988, the budget requirements would depend on what assumption is made about future use of the facility. If the assumption is that the reactor be closed permanently, then we would proceed to place it in a safe cold-shutdown condition. This would require approximately $10 million in FY 1988. If the assumption is that FY 1988 be a year of continued upgrade and analysis of the reactor in preparation for future operation, the budget requirement would be approximately $16 million.

Funding for TPP is based on (1) performance of one campaign per year to process HFIR-irradiated targets and to recover and purify the transuranium element radionuclides, (2) preparation of targets for reirradiation, and (3) maintenance of the TPP facilities and equipment. Campaign 67 was begun at the TPP in January 1987 and is almost complete. Preparation of new targets and maintenance of TPP facilities are planned during the remainder of FY 1987. A campaign will be made at the TPP in FY 1988 to process 15 irradiated targets remaining from earlier HFIR Operations, whether or not HFIR remains closed. Thereafter, if HFIR remains closed, necessary shutdown operations would begin. The efforts required to solidify and safely store all radioactive materials in the TPP inventory and to clean out the facilities and equipment to a safe standby status are estimated to require full-time effort for at least two years. Thus, full funding will be needed at TPP for several years after a decision that HFIR will not be started.

(No Question 18.)

Question 19. Please provide the schedule and funding profile for the Advanced Neutron Source through project completion assuming the following:

a. The President's budget request of $3 million is approved by Congress; and

b. Congress approves the $7.7 million level you say is required to continue an orderly program.

Funding for the Advanced Neutron Source of $7.7 million in FY 1988, as requested by the Laboratory, would support progress towards a request for FY 1991 line-item money for detailed design work and FY 1992 construction authorization. The reactor would go critical in FY 1996. Three million dollars of the FY 1988 funds would be spent outside ORNL on collaborative work in other organizations. The Idaho, Argonne and Brookhaven National Laboratories, the Universities of Georgia and Virginia, and the Babcock and Wilcox fuel fabrication plant in Virginia would receive more than half of the subcontracted funding for collaborative work on the project. Other work would be placed, after evaluation of the most appropriate and expert organizations, with other universities or colleges, environmental and site selection experts, and architect-engineers.

Funding of only $3 million in FY 1988 (the President's Budget request) would limit the work next year to a continuation and completion of some of the high priority tasks begun in FY 1987, and collaboration with other organizations would be very limited ($600,000 - less than the $750,000 in the present year). The construction project would be delayed two years, given also the post-1988 funding profile proposed by DOE, and it would be 1999 before the facility came into use by the research community.

Question 20. Please provide additional information on your proposed Ceramics Advanced Manufacturing Development and Engineering Center (CAMDEC).

a. What is the scientific justification for such a Center?

Advanced or high-performance ceramics are inorganic, nonmetallic materials having combinations of fine-scale microstructure, purity, complex compositions and accurately controlled additives. These materials uniquely combine high strength, high hardness, and dimensional stability, but require a level of processing science and engineering far beyond that of traditional ceramics. Thus, commercialization requires that cost-effective and reliable processing techniques be developed which yield levels of purity, perfection and scale not previously achieved.

Recognizing this, The National Academy's Report to Senior Government Officials(1) and a U. S. Department of Commerce Workshop on the future of the U. S. advanced ceramics industry(2) recommended the creation of a large interdisciplinary center to carry out research on the basic science and engineering of ceramic processing.

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1. "The National Academy's Report to Senior Government Officials", Report of the Research Briefing Panel on Ceramic Composites, National Academy Press, Washington, D. C., 1985.

2. "U. S. Department of Commerce Conference Proceedings", A National Prospectus on the Future of the U. S. Advanced Ceramics Industry, NBS IR 85-3240, July 1985.

In response to this recommendation, CAMDEC, Inc. has been designed to systematically evaluate and develop the processing and manufacturing technologies necessary to bridge the gap between R & D and commercialization.

b. What is the DOE-mission justification for such a Center?

The DOE supports both fundamental studies of ceramic model systems and generic research on ceramics for applications in the production, conversion and utilization of energy. The transfer of the technology developed by these programs to the private sector is the key to the rapid commercialization of advanced ceramics. This transfer has been facilitated by recent legislation such as the Stevenson-Wydler Technology Innovation Act (P.L. 96-480), the Federal Technology Transfer Act of 1986 (P.L. 99-502), and the Executive Order on Facilitating Access to Science and Technology. These permit Federal laboratories to enter into a broad range of cooperative R & D programs. Under such legislation, an industrial consortium, such as CAMDEC, Inc., can provide a new and innovative mechanism to promote and enhance interaction with and technology transfer to the private sector.

c. What is the proposed level of CAMDEC funding? What DOE funds will be required and what industry funds will be required?

CAMDEC, Inc. is proposed as an industrial consortium of U. S. advanced ceramics companies which is primarily funded through annual membership fees. Initial industry funding of ~ $2 million, growing to an annual level of $6 million to $8 million in four years, is anticipated.

Government funding may be sought on a cost-sharing basis for the first three years of the Center's operation. This would permit a rapid start-up necessary for the Center to compete on a timely basis with the government-supported programs of Japan and others.

Question 21. Please provide additional information on your proposed Advanced Semiconductor Processing Center (ASPC).

a. What is the scientific justification for such a Center?

Development of the advanced processing techniques proposed for the ASPC is essential for fabricating future submicron electronic and photonic devices. These advanced processing techniques occupy a position of unique importance in the device fabrication sequence that far outweighs their apparent cost and complexity, and the U. S. semiconductor industry is far behind the Japanese in development of these techniques.

b. What is the DOE-mission justification for such a Center?

The semiconductor industry occupies a position of unique importance that affects national defense, communications, computers, advanced energy systems, and future worldwide competitiveness in all these areas. Kerber of DOD at the recent semiconductor workshop referred to advanced processing of semiconductor materials as the new critical materials area that was much more crucial than previous worries concerning availability of critical materials like chromium. Given these imperatives and recognizing that the U. S. semiconductor enterprise has no coordinating government body like MITI in

Japan, it seems well within DOE's interest to develop and promote these advanced processing techniques in support of its defense and energy missions.

c. What is the proposed level of ASPC funding? What DOE funds will be required and what industry funds will be required?

The proposed ORNL ASPC would proceed in three phases, if funded. Phase I would require about $2.5 million of new operating funds in FY 1987-88 to initiate research and organize the ASPC around existing DOE facilities and agreement by DOE to use $2.5 million of equipment funds they have already allocated. The $2.5 million of new funds would need to be supplied by DOE since DOE would take the initiative in organizing the industry consortium. In phase II approximately $20 million would be required in FY 1988-90 to establish the building and equipment needs of the consortium. These funds could be all DOE, all industry, or shared funds. Operating costs would be $5 million per year and could be shared funds. The ultimate size of the ASPC consortium, phase III, would be determined by industry needs. The estimated operating funds of $10 million to $12 million per year would be shared funds.

A similar solution to this problem has been proposed separately by DOD, the Defense Science Board, and IEEE. Their proposal recommends four such centers to be built from scratch at a cost of about $30 million each and an operating budget of about $20 million per year. The main difference is that an ASPC located at a National Laboratory not only leverages the available funds by taking advantage of existing equipment and expertise but also has access to all the other facilities of the National Laboratory, such as major user facilities, for support analyses.

Question 22. You note that the present arrangements between the National Laboratories are "but pale shadows of what could be a purposeful and aggressive engagement of the National Laboratories in this country's industrial economy". What suggestions do you have that would change this situation, and how might this Committee be helpful in this regard?

The answer to this question is not simple. As a start, the Committee could be helpful in promoting technology transfer by stating explicitly that this is a mission of the Nation's multiprogram laboratories and that the Department of Energy explicitly assign them this role. Much more needs to be done and can be done to engage the National Laboratories in this country's industrial economy. This in fact is a topic of a paper I am preparing. I will be pleased to send you a copy when I finish.

Question 23. Several synchrotron installations in the Nation provide a base for a strong U. S. semiconductor industry thrust in x-ray lithography. Please supply the following information:

a. What are the critical elements of a synchrotron system for use in x-ray lithography?

b. What are the critical elements of surface science for use in x-ray lithography?

c. What centers and/or pockets of expertise exist in the U. S. which might be tapped as a national resource?

d. What is unique about Brookhaven's capabilities in synchrotron radiation as opposed to the expertise that exists at the Stanford Synchrotron Radiation Laboratory, Lawrence Berkeley Laboratory, Argonne National Laboratory, and the University of Wisconsin Synchrotron Radiation Center?

e. What is unique about Oak Ridge's capabilities in surface science as opposed to the expertise that exists at other National Laboratories?

Question 24. What are the technical barriers, if any, and engineering challenges to be solved in building a synchrotron suitable for use on a semiconductor production line? Please discuss these for both (a) conventional and (b) cryogenic approaches.

Question 25. What are the technical barriers, if any, and engineering challenges to be solved in surface science for use of x-ray lithography on a semiconductor production line?

First, it must be recognized that the challenges that must be solved are not just in the area of x-ray lithography but include all the advanced processing techniques outlined in Question 21. In addition to patterning and pattern transfer of mask structures which can be done by x-ray lithography, one must also do ion implantation doping, dry etching with a plasma or laser-assisted reactive gas, deposition of insulating layers and conducting lines by ion beam and laser techniques, etc. The technical barriers that must be solved arise because future device structures will have features as small as a few atomic dimensions. Therefore we must learn to etch features this small with vertical side walls and no lateral spreading; we must be able to implant ions into solids with this accuracy; we must be able to put down metal lines that are a few atomic dimensions wide, that are still good conductors, and that are adherent; and we must be able to control induced interactions between materials such as metals and silicon and material defects to a few atomic layers or the fabricated devices will not work. Neither the techniques and equipment needed to perform these operations at the required scale, nor the underlying materials science required to control the induced interactions have been developed as yet. This is why an ASPC such as proposed is needed.

Question 26. How will ORNL and BNL transfer their expertise in synchrotron technology and surface science to the equipment manufacturing and semiconductor industries?

I can only speak for ORNL. The most direct mode of technology transfer is through collaborative projects with equipment manufacturers and semiconductor companies who work with ORNL scientists in one of the 12 DOE User Facilities or Collaborative Research Centers. For example, one R & D collaboration, carried out in conjunction with the Surface Modification and Characterization (SMAC) Collaborative Research Center (CRC) at ORNL, is to develop a microwave plasma processing system in collaboration with IBM and Eaton Corporation to be used for dry etching of submicron device structures. Eaton Corporation, an equipment manufacturer, would build the apparatus developed in the collaboration for sale to the semiconductor industry, probably through an exclusive licensing arrangement. The current dry etching equipment market sales are about $300 million per year. It is agreed that microwave plasma etchers will displace current dry etchers in the next few years; at present only the Japanese have developed such equipment. IBM is interested in the collaboration to insure that the equipment developed performs to the standards required in their manufacturing operations. The work is being done at ORNL because we already have the equipment and expertise at SMAC required for the work, thus greatly reducing start-up time.

Question 27. How will the construction of a conventional synchrotron at the BNL site in the same energy regime as the LBL 1-2 GeV Synchrotron Light Source enhance U. S. industry's synchrotron manufacturing capability?

This is a question that should be directed to members of the semiconductor community. The question of synchrotron lithography is a complex one with many alternatives, and the ultimate solution depends very much on the path chosen by the semiconductor manufacturing community or individual companies.

Question 28. How will performance of surface science studies at a conventional synchrotron at the BNL site in the same energy regime as the LBL 1-2 GeV Synchrotron Light Source enhance U. S. semiconductor industry? Please explain why such surface science studies could not be done at other synchrotron centers?

The surface science performed at synchrotrons for x-ray lithography studies are designed to determine the materials interactions that expose the polymer resists and how effectively the exposed resists can be etched away to give features of the desired dimensions and aspect ratios. These interactions are a function of the resist and the wavelength, intensity, etc., of the synchrotron radiation. Since most of the synchrotrons discussed have similar properties, there are only minor advantages to using one versus the other. However, it must be recognized that the actual radiation is a small part of the entire problem for future small devices. Making the mask that is exposed by the radiation, for example, is a much bigger and technologically more challenging problem; using clean room conditions for exposing and developing the resist is another requirement. These are areas that are usually the problem of the semiconductor manufacturer so any such experiments at an existing synchrotron will require elaborate preparation by the industry which uses the synchrotron. IBM has prepared such a line at the BNL synchrotron.

Question 29. How will ORNL draw upon other laboratories and research centers for a more effective technology transfer?

Question 30. The end user for synchrotron development is the semiconductor industry. Please discuss competing lithographic approaches and competing x-ray sources for x-ray lithography, and the types of surface science studies necessary for each. How will increased resist sensitivities affect industry choices?

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Battelle
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April 27, 1987

Honorable Manuel Lujan, Jr.
Ranking Republican Member
U.S. House of Representatives
Suite 2321, Rayburn House Office Building
Washington, DC 20515

Dear Congressman Lujan:

Enclosed are the answers to the questions you asked of the Pacific Northwest Laboratory in your letter of April 10, 1987.

If there are any additional questions or information I can provide, please contact me on 509-375-2201, or Jack Bagley on 202-785-8400.

Very truly yours,

W R Wiley

W. R. Wiley
Director

WRW/ib

Enclosure

RESPONSE TO QUESTIONS
CONGRESSMAN MANUEL LUJAN, JR.
RANKING REPUBLICAN MEMBER
U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

Question 1. One of our earlier witnesses, Dr. Robert Hansen, Director of Ames Laboratory, testified that he perceived that the DOE now has a facilities focus rather than an energy focus. Do you believe this to be the case, and if so, do you think this change in focus is appropriate?

a. I do not know the exact context in which Dr. Hansen made the statement regarding a perceived focus by DOE on facilities rather than energy. I believe such a statement is dependent upon one's perspective. Many DOE laboratories have justified the need for specific facilities as part of a larger mission. However, I also believe all the Energy Research multiprogram laboratories are in need of general purpose facilities and overall upgrades to existing facilities to accommodate new or expanded programs. I would also speculate that most universities such as Iowa State, are in dire need of new, state-of-the-art, laboratory facilities. I do not believe DOE has lost focus on energy research; however, the combination of cheap oil and budget deficits have combined the lessen what used to be a larger focus on energy R&D programs.

Question 2. The December 1985 Energy Research Advisory Board report on "Guidelines for DOE Long Term Civilian Research and Development" recommended that the BES budget should establish a "separate budget category for facilities construction and operation." Do you agree with this recommendation?

a. The recent ERAB report recommendation that "BES should establish a separate budget category for facilities construction and operation" is difficult to argue against in principle. In fact, BES does plan on a certain amount of funding in its budget requests for each facility's operation, but not at line item level in the budget to Congress.

The lengthy and uncertainty of the federal budget process, in my view, precludes a specific budget item for each facility's operation. In addition, the time to get approval for reprogramming, etc., inevitably leads to inefficient use of limited resources. The pace of scientific research is so rapid that a certain degree of flexibility should be maintained to accommodate unexpected needs or unplanned support of user facilities by industrial researchers or international interests.

PNL does not, at this time, have any major user facilities that are funded by DOE that would be affected by a change in funding approach.

Question 3. As you know, the President has proposed constructing the multi-billion dollar Superconducting Super Collider (SCC).

a. What is your view of the project?

b. What impact might it have on funding for other research priorities?

c. If there was clearly a stark choice between additional funding for academic or National Laboratory research, and construction of the SCC, what choice would you advise this Committee to make?

a. The proposal to build the Superconducting Super Collider has unquestionably received ample attention. As a scientist (but not a physicist), I can appreciate the potential a new, high level physics machine can bring to science in general, U.S. science in particular, and the surrounding geographical region in which it is located.

Even with the best intentions of everyone to avoid impacts on DOE budgets, the amount of dollars to build and operate effectively the SCC will, I believe, in some way affect DOE's other research programs. Equally stark is the fact that the Department's (and Federal government's) budget cannot increase at the rate to accommodate SSC and other research programs under today's federal budget conditions. I believe there are enough uncertainties in the areas of U.S. economic growth, arms control, and oil supply security that the U.S. should wait for three years before committing to SSC as a construction project. The preliminary requirements--site selection, environmental documentation, and associated R&D, etc., however, should proceed if Congress as a whole approves the SSC.

Question 4. The Committee is often confronted by individuals and groups requesting moneys for research proposals and facilities that have not undergone the normal merit review process. How should the Committee treat such requests? What review mechanisms or policies should be implemented to ensure that the taxpayer dollars are being well spent?

a. Whether the request for monies for research proposals and facilities originates from the funding agency or a congressional committee, it should undergo a merit review process. We recommend using the funding agency merit review processes that are already in place. This would provide assurance that funded proposals are of equal merit as perceived by the scientific community.

Question 5. *What is the level of Work for Others at your Laboratory, and what percentage is this level of your total laboratory funding?*

a. The Table shown below depicts the percentage of total Laboratory funding received by PNL from other Federal agencies in 1987 and projected funding for 1988-1989. Please refer to the Answer to Question 6 for a description of the current status of our attempts to reclassify catagories of Work for Other Agencies which we view as supportive of DOE Missions.

	FY 1987	FY 1988	FY 1989
Other Federal Agencies			
DOD	30.0	32.0	33.0
EPA	3.8	4.9	5.6
Other	3.0	3.0	3.0
Total OFAs	36.8	39.9	41.6
NRC	19.0	19.5	20.0
Total Work for Others	55.8	59.4	61.6
Total Laboratory Funding	209.4	241.5	237.0
WFO % - Including NRC Work	26.6	24.6	26.0
WFO % - Excluding NRC Work	17.6	16.5	17.6

Question 6. *Please commit on the DOE-imposed ceilings regarding the amount of Work for Others your laboratory. Is the level too high? Too low?*

a. The present DOE-imposed ceiling on PNL's related services activities (Work for Others) excludes work for NRC from the limitation in recognition of the requirement of Section 206 of the Energy Reorganization Act of 1974 that the Department furnish the research services required by the Commission. We are currently negotiating with

DOE to establish an agreement that national security work conducted by PNL for other agencies should be treated as a DOE responsibility and accordingly not be subject to the limitation. If we are successful in establishing this agreement we do not anticipate a problem with the DOE-imposed ceiling on Work for Others. If agreement is not reached the ceiling may well be too low to allow continuation of this work as anticipated.

Question 7. On January 14, 1987, the Department of Energy promulgated a new regulation (48 CFR Part 970, Acquisition Regulation) prohibiting lobbying by its contractors.

a. Do you believe it is proper for Laboratory management or staff to approach Congressional Members or staff with proposals for additional funding for new or ongoing programs in the absence of a substantive request for such information? What is the policy of your laboratory in this regard?

a. We subscribe to the principle that Laboratory management should be fully responsive to substantive requests from Congressional members for information on proposals for additional funding for new or ongoing programs. We do not believe it appropriate, however, nor is it our policy to initiate approaches to the Congress on such matters in the absence of a substantive request.

b. One provision in this regulation allows contractors to recover costs responding to Congressional inquiries only if written information provided in such response is concurrently furnished to the DOE.

i. Do you believe this will inhibit you in substantiating orally-transmitted information or providing other written information in response to telephone requests by Congressional Members or staff?

ii. What, if any, difficulties, additional costs, etc, do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your laboratory's additional costs because of this requirement?

a. We do not anticipate any difficulties or additional costs as a result of complying with this requirement. The necessary procedural controls to assure that materials transmitted to Congressional Members and staff, whether in response to telephonic requests or otherwise, are simultaneously transmitted to DOE are relatively simple to implement and should not involve significant costs.

c. Another provision of the regulation limits the recovery of contractor costs incurred in providing written information to congressional staff during oversight visits to the contractor-operated laboratories. Such costs may only be recovered if the contractor provides the information concurrently to the Department of Energy.

i. Do you believe this will inhibit you in providing written information to congressional staff?

a. We do not anticipate that we will be inhibited by this provision of the regulation in providing written information to Congressional staff during the course of oversight visits to PNL.

ii. What, if any, difficulties, additional costs, etc, do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your laboratory's additional costs because of this requirement?

a. We do not anticipate encountering any difficulties or additional costs as a result of complying with this requirement. As indicated in the response to Question 7.b.ii, the necessary procedural controls to assure compliance are relatively simple to implement and should not involve significant costs.

d. What, if any, concerns do you have with any other provisions of the regulation?

a. While some of the language used in drafting the portion of the regulation excepting certain Congressional contacts from coverage of the anti-lobbying provision (49 CFR 970.3102-7(b) (1)) is less flexible than we might have preferred, we do not have any significant substantive concerns with the regulation. These drafting concerns are reflected in the following suggested revision of Section 970.3102-7(b) (1) (suggested deletions are shown in brackets):

> "Providing members of Congress, State legislatures or subdivisions thereof, or their staff members or staff or cognizant legislative committees, with factual, technical and scientific information or advice or contractor-employed experts on topics [directly] related to performance of the contract, through hearing testimony,

> statements or letters in response to a request (including a Congressional Record notice requesting testimony or statements for the record at a regularly scheduled hearing) made by the recipient member, staff member or legislative committee staff member: provided such information or advice is concurrently furnished to DOE through the Contracting Officer or designee; and further provided that costs under this paragraph for transportation, lodging or meals incurred for the purpose of providing factual, technical and scientific information or advice directly to legislative members, or their staff members or staff of legislative committees, are unallowable unless incurred pursuant to a request for such informal presentation [made through DOE], or, in the case of providing testimony at a regularly scheduled legislative hearing, incurred pursuant to a [written] request for such formal presentation made by the Chairman or Ranking Minority Member of the committee or subcommittee conducting the hearing."

Question 8. What use do you make of external review groups, other than DOE groups, in evaluating and monitoring your various research programs?

a. As is typical for most scientific organizations, PNL makes extensive use of peer review of scientific programs to evaluate scientific quality, merit and credibility. We find external review groups to be most valuable for research that is at the "leading edge", because it provides the Laboratory with increased technical depth and a broader perspective for prospective evaluation and decision. The peer review groups are used to evaluate technical direction and progress of scientific projects from the initial exploratory phase through completion.

Question 9. What are the major institutional issues facing your laboratory? How are you addressing them?

a. The major institutional issues facing the Pacific Northwest Laboratory are threefold: 1) Availability of general purpose equipment and general purpose facilities, including laboratory office space, 2) the inability to acquire new scientific equipment to support and enhance research programs, and 3) the difficulty that 3,000 scientists in many different buildings in a dispersed area have in communicating with each other and having access to computational equipment, especially supercomputers, 4) adequacy of existing facilities to achieve the missions of PNL.

PNL is unique in many respects among DOE's multiprogram national laboratories in that it is truly multiprogrammatic; it has no large program that dominates in size over all others. As a result, it has been difficult to get any DOE programs, with limited resources, to assume an institutional ownership of PNL. The Biological and Environmental Research Program, the smallest and least visible part of the Energy Research Programs, has traditionally been the source of funding for general purpose equipment and general purpose facilities requirements. In addition, being the non-defense part of the DOE site at Hanford is not conducive to obtaining sources of funding from Defense Program budgets. General purpose fundings has averaged $21.0 million a year for the last ten years and needs are always identified at as $5.0 million minimum level.

The last program-related scientific laboratory constructed by the government at PNL was completed in 1971. Since that time the Laboratory's growth has been accommodated through Battelle-built laboratory space or through leased space for offices. The Molecular Sciences Research Center (see Question 13) will partially address the Program aspect of our dilemma, but general purpose laboratory space will continue to be a long-term problem.

The inability to get our scientists and engineers in general proximity to each other obviously is an impediment to communication, but the computer revolution has made an already difficult problem worse. The need to have access to computers to support scientific endeavors is critical in today's environment. The inability to have access to supercomputing resources is gradually being rectified but not altogether easily. DOE Defense Programs is installing a supercomputer at the Hanford site and PNL will have access. Access to off-site supercomputers is also possible but not always easily. Without a supercomputer easily accessible for scientific requirements, PNL's ability to conduct research efficiently and effectively will be difficult to maintain.

Question 10. The Energy Research Advisory Board (ERAB) recently issued its report "Geoscience Research for Energy Security." Please comment on each of the four principal recommendations of that Report:

a. The DOE should modify its policy and give the highest geoscience research priority to shorter-term, lower-risk options for energy supplies upon which the nation will be primarily dependent for at least the next two decades.

a. This is an excellent recommendation as long as its implementation does not totally eliminate longer-term R&D. This is a concern because the funding level and priority for geoscientific R&D within DOE is very low relative to the application of the technology. Geoscience work within

DOE supports energy resources exploration and characterization, resource extraction and conversion, waste management and other environmental matters. The issue of primary importance is that there is a great deal of advanced technology (e.g., computers, robotics, smart sensors, remote sensing) which already exists or could emerge in the near-term from a variety of federal laboratories and contractors. This technology, if properly exploited within the field of geoscience, would significantly impact the efficient supply and utilization of the nation's primary energy resources, (i.e., oil, gas, coal, and nuclear). Unfortunately, DOE's geoscience work is weakly funded, currently, and DOE is organized in such a manner that the emphasis is either immediate, service-oriented geoscientific applications or very long-term, high risk basic science. Too little emphasis is given to the middle ground which is the development and/or adaptation of advanced technology to the field of geosciences. Therefore, DOE should implement this ERAB recommendation.

b. *Establish in the DOE an Office of Geoscience Research to develop and administer a strategic plan for geoscience research activities within the Department, especially in oil and gas and other liquid hydrocarbon conversion options.*

a. Geoscientific work within DOE is primarily supportive of other programs making strategic planning and implementation difficult. Some type of centralized organization with a focus on geoscience research and development is needed, as is reasonable funding priority. However, it is not clear that a new line organization within DOE is required to meet ERAB's intended goal. It is likely that the geosciences should be handled in a manner similar to the material sciences or high-energy physics within DOE. In other words, geosciences is also a cross-cutting technical field with applications in numerous DOE programs. Therefore, geosciences should have its own "home field" with its own strategic planning and budget prioritization. Currently, it is difficult to find funding for the adaption of advanced technology to geoscience activities. This could be done within the Office of Energy Research if they were given the responsibility for a basic sciences program which would cross-cut the multiple application areas.

c. *Establish oil and gas research centers within each of the six major oil and gas provinces of the United States to conduct and coordinate interdisciplinary problem-oriented research in the following ares all of which mitigate the problem of domestic hydrocarbon supply: enhanced oil recovery, unconventional natural gas recovery, subtle petroleum trap exploration, and geological basin analysis.*

a. Two factors motivated this ERAB recommendation. The first is that the aforementioned interdisciplinary problem-oriented research is timely and very necessary to increase the supply and reduce the marginal cost of domestic energy production It is also true that each major oil and gas province has its own unique geological setting and behavior. The second motivating factor is that the nation's universities are finding it very difficult to attract and adequately educate the next generation of scientists and engineers for the domestic energy industry. Therefore, the concept of six oil and gas research centers is probably a sound one. However, it does not seem necessary to create new federal research laboratories even if they are on a university campus. It would seem more efficient if the DOE multi-program laboratories were given the lead with a strict mandate to subcontract a large percentage of the actual research and development to universities. Thus, DOE would have a good blend of the interdisciplinary integrated, and management-oriented work from the federal laboratories and the deeper, more individual grant type work from the universities. New research centers simply add overhead costs, equipment and facilities costs, and greater fragmentation of communications. The existing DOE laboratory structure should be used in conjunction with major university involvement.

d. Increase oil and gas research funding by an initial annual increment of $50 million, primarily to support the regional research centers.

a. The funding increment is clearly desirable. The primary energy resources for the next few decades will be oil, natural gas, coal, and nuclear. In addition, environmental protection and waste management in general will continue to be important issues for DOE. Geoscience plays an important role in all of these areas. Therefore, the initial annual increment of $50 million appears to be appropriate for the support of six regional research centers, unless only one or two centers is to be established each year. New money is required and $50 million may be the lower limit necessary to foster a critical mass of geoscientific studies in regional research centers.

Question 11. Please describe the Strategic Defense Initiative (SDI) efforts you have been and are conducting at your laboratory. What are the actual and estimated SDI funding levels for your laboratory you have reached (both DOE and DOD) for each of FY 1987, and FY 1988?

a. PNL is involved in several key areas of SDI including space nuclear power, sensors, laser mirrors, and advanced defensive systems development. However, our role, while growing significantly, is small by comparison to other national laboratories. Several of the projects are classified so detailed descriptions can not be provided.

Multimegawatt Space Power Program

1. Reactor Fuels Technology

PNL is the lead laboratory for developing reactor fuel for MMW space nuclear power systems. This effort currently includes cermet fuel development at PNL and ANL, UN fuel microsphere development at LANL, UN pin-type fuel development at LANL, gas-cooled reactor particle fuel development at BNL and Sandia, and fuel irradiation testing at HEDL. The total managed effort in FY-87 is $2.6M. Funding for work at PNL is:

DOD FY 86 - $320,000 FY 87 - $0 FY 88 - TBD
DOE FY 86 - $0 FY 87 - $475,000 FY 88 - TBD

2. Reactor Thermal Hydraulics

PNL is the leading laboratory for reactor thermal hydraulics analysis in the U.S. This work involves identifying the developing calculational codes that can be used to design and evaluate the various proposed reactor concepts.

DOD FY 86 - $250,000 FY 87 - $0 FY 88 - TBD
DOE FY 86 - $25,000 FT 87 - $0 FY 88 - TBD

3. Concept Development

PNL has developed a concept called RMBLR (Rotating Multimegawatt Boiling Liquid-metal Reactor) which has the potential to meet all SDI multimegawatt power requirements.

DOD FY 86 - $250,000 FY 87 - $100,000 FY 88 - TBD

The following descriptions of other direct-funded SDI efforts are limited because of the classification level.

1. Design and develop an advanced defense system

SDIO FY 86 - $50,000
FY 87 - $250,000
FY 88 - $500,000

2. Study feasibility of using scintillation counting in space

SDIO	FY 86 - $300,000 (some funds carried over into FY 87 for continuing work
	FY 88 - none anticipated

3. Fabricate large laser mirrors

DOD	FY 86 - $395,000
	FY 87 - $871,000
	FY 88 - $728,000

Question 12. What pressing needs of your laboratory are not addressed adequately in the DOE's FY 1988 budget request? What funding would be necessary in FY 1988 to meet these needs and what will be the consequences if these additional funds are not made available?

a. As noted in the Answer to Question 9, PNL's most pressing needs are additional general purpose equipment and multiprogram laboratory space.

PNL's general purpose equipment budget has averaged less than $1.0 million for the last 10 years and general plant project funding has averaged approximately $1.5 million over the last ten years. These funding levels are one-third of normal requests. In addition, PNL has not had a new laboratory facility authorized by DOE since 1967.

These constrained budgets have continued in the face of significant programmatic growth, the result of which scientists, engineers, and support staff are dispersed in many facilities, leased office buildings, Battelle-owned laboratories, and trailers. The impact is inefficiency, lost opportunities and poor morale among our staff. The ability of PNL to be a first-class scientific and technical resource to the DOE is in jeopardy without additional resources for equipment and laboratory upgrades and consolidated office space.

Question 13. Please provide additional information on your proposed Molecular Sciences Research Center.

a. What is the scientific justification for such a Center?

a. Molecular Science is a common thread that weaves itself through almost all chemistry, biology, environmental and materials research. A more complete determination, characterization and theoretical analysis of molecular structure and measurement and prediction of the consequences of molecular structure, particularly at interfaces, is needed to achieve the necessary breakthroughs in these important technological areas. A survey of research projects at PNL in the health, environment, chemical and materials areas showed that over 75% of the projects are affected by interfacial phenomena. At the molecular level, common principles manifest themselves, and the barriers between the different disciplines disappear. Thus, molecular level research to understand the nature of interfaces can be expected to contribute significantly to the discovery and development of new technologies for a broad range of applications.

Recent developments in both the experimental and computational science areas have made the study of complex problems at the molecular level a reality. For example, the development of new surface analytical techniques and dynamic laser spectroscopy permit the detailed study of species and reactions on material surfaces (i.e., an interface) at atomic resolution. New computer methodologies, when combined with the speed of supercomputers, allow the theoretical analysis of molecular surface reactions which were previously considered impossible.

The Molecular Science Research Center at PNL will integrate both theory and experimental research for the study of molecular science. A combination of different experimental tools and advanced computational equipment will facilitate data analysis, model building and experimental design tasks and significantly reduce the time and substantially increase the probability of achieving key scientific breakthroughs. Support for this approach can be found in a recent report by the Committee on Science Engineering and Public Policy of the National Academy of Science entitled "Research Briefings 1986 - Science of Interfaces and Thin Films". They conclude that the best vehicle for the study of interface science is a center which brings together the multitude of experimental and computational resources required to attack this most complex research frontier.

b. What is the DOE-mission justification for such a Center?

a. A number of serious issues face DOE as we move toward the 21st Century; viz adequacy of the nation's energy supply; increased concerns with health and environmental effects of energy production, transmission and distribution; a continued strong national security program; and the competitiveness of US industry in the international marketplace. It is well recognized that only technological breakthroughs of a revolutionary, rather than evolutionary type, will enable us to improve the overall quality of life over the next two decades. We at PNL are convinced that molecular level knowledge will be the key to these revolutionary discoveries.

The vertical integration from basic discovery to technology or problem solution is firmly entrenched at PNL. We have identified numerous research opportunities where basic research in the Molecular Science Research Center can significantly impact the DOE programmatic work in environmental, health, materials and chemistry research. With respect to DOE's environmental responsibilities, the MSRC will contribute to the understanding of the transport and fate of energy related contaminants. Future research must turn from a focus on studies within separate environmental compartments to studies of the pervasive spread and movement of contaminants between environmental media, extending even to global scales. Multi-disciplinary research on contaminant fixation, migration and reactions at environmental interfaces is a crucial area of molecular sciences, necessary to understand the species of evolving contaminants and their rates of transfer through multi-component environmental systems on a microscopic level.

DOE's Health Effects research will benefit from MSRC's application of molecular biology to the prediction of health effects from cellular and molecular measurements. In this fashion, we will lessen our current dependency on animal studies that are being used to probe the effect of energy byproducts on man and his environment. Also, molecular toxicology research, which investigates the mechanisms of radiation and chemical carcinogenesis, will benefit from a strong molecular sciences component that enables the experimenter to model and thus predict important effects at the molecular level.

The MSRC will increase the understanding of phenomena and properties important to the development of energy related materials and hence, will provide new long-term options for selection of materials. Research designed to create the new ceramics, polymers or composites of the future must focus on materials with unique properties that ensure long-term stability and performance under hostile conditions. Materials will need to be specially designed (i.e., tailor-made) for their intended purpose to achieve this goal. The MSRC will focus on the needed detailed experimental measurements and theoretical understanding, emphasizing interfaces which are traditionally the weak link in a material structure.

The MSRC will also support programs that are aimed at the discovery of new chemical and processes which better utilize our existing energy feedstocks and reduce the formation of toxic byproducts from U.S. energy consumption. Fundamental knowledge in the area of molecular structure pertaining to the complex nature of the chemistry at interfaces is required to advance many of the DOE chemistry programs. These programs

range from the main stream physical chemistry to the development of new analytical techniques.

In summary, the MSRC will be a National resource where users from DOE National Laboratories, academia and industry can access a state-of-the-art interdisciplinary facility which is tightly coupled to DOE's programmatic missions. Most importantly, the collaboration with industry will hasten the transfer of new discoveries that we expect from this synergism into the industrial sector; and collaboration with universities will lead to a new generation of scientists trained in the interdisciplinary areas that encompass molecular science.

c. *What is the proposed level of Center funding?*

a. **Total estimated cost for the MSRC, in 1987 dollars, is $100M, which includes $60-70M of experimental instruments and computational resources. The facility will be a building approximately 100,000 ft^2, consisting of laboratories, computer area, office space, conference rooms, lecture halls, common storage and electrical/mechanical equipment space, 75 offices will be provided to house 50- permanent staff and an equal number of visiting scientists, graduate students post-doctoral associates and other PNL scientists not permanently assigned to the MARC but closely associated with MSRC projects.**

Annual operating costs are expected to $10-12M. This will cover administration, permanent staff research and equipment and building maintenance.

Battelle
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March 31, 1987

Nelson Milder
Science Consultant
Science, Space and Technology Committee
U.S. House of Representatives
R-374
Washington, D.C. 20515

Dear Nelson:

Enclosed is the table showing funding totals for the Pacific Northwest Laboratory for FY 1985-86-87. This is provided in response to the request of Chairman Lloyd during the recent hearing with the multiprogram laboratory Directors.

Sincerely,

John F. Bagley
Manager, Office of External Affairs

JFB/fm

Enc.

Pacific Northwest Laboratory
Current Budget by DOE Program
($ in K's)

Direct Programs	FY 1985 Actual	FY 1986 Actual	FY 1987 Est.
Fossil Energy	1,600	1,400	1,700
Nuclear Energy	13,100	14,300	13,300
Civilian Nuclear Waste Mgmt	22,200	25,400	26,000
Conservation & Renewable Energy	17,800	16,100	13,700
Defense Programs	15,700	15,100	17,900
Energy Research	18,200	17,700	18,600
Environment, Safety & Health	4,900	5,000	4,500
Other DOE	40,400	54,600	49,500
TOTAL DOE	133,900	149,600	145,200
Work for Others	48,500	49,700	56,500
TOTAL Operating	182,400	199,300	201,700
Construction and Equipment	8,500	7,100	9,000
TOTAL	190,900	206,400	210,700

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439

RECEIVED
MINORITY

APR 23 1987

COMMITTEE ON
SCIENCE & TECHNOLOGY

April 21, 1987

The Honorable Congressman Manuel Lujan, Jr.
Committee on Science, Space,
and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Bldg.
Washington, D.C. 20515

Dear Congressman Lujan:

Thank you for your letter, dated April 10, 1987, in which you asked me to answer several questions raised by Republican Members of the Subcommittee on Energy Research and Development. Enclosed are the list of questions and my responses.

I was honored by the opportunity to offer testimony before the Subcommittee and am pleased to respond to the Members' questions. Should the Members desire additional information, I shall be happy to provide it.

Sincerely,

Alan Schriesheim
Director

AS:rt

Enclosure

1. **QUESTION: One of our earlier witnesses, Dr. Robert Hansen, Director of Ames Laboratory, testified that he perceived that the DOE now has a facilities focus rather than an energy focus. Do you believe this to be the case, and if so, do you think this change in focus is appropriate?**

   RESPONSE: The Department's support of energy-technology R&D has declined over the past seven or eight years, while its support of basic research, including funding of facility construction, has increased. To this extent, there certainly has been a change in emphasis within the Department's civilian R&D programs.

   I believe that the Department's plan for major facility starts at the multiprogram laboratories is essential to the health of the U.S. research enterprise. Much of the retrenchment from near-term energy demonstration projects was probably warranted. However, we have now reached the point where further cuts in applied energy research, in many cases, will end U.S. participation in the development of the next generation of energy technologies.

2. **QUESTION: The December 1985 Energy Research Advisory Board report on "Guidelines for DOE Long Term Civilian Research and Development" recommended that the BES budget should establish a "separate budget" category for facilities construction and operation." Do you agree with this recommendation?**

   RESPONSE: Because of its demonstrated abilities to successfully plan, build, and operate national user facilities for scientific research, DOE has an essential role to play in this area. The fundamental issue here is how to preserve a balance between funding for the construction and operation of large national user facilities and BES funding of individual investigators both at universities and at the national laboratories. The National Research Council recently identified the national needs for new facilities, and ERAB has endorsed a priority role for DOE, particularly the BES program, to meet these needs over the next decade. In the past, however, increased operating costs for facilities have come at the expense of BES research budgets at the national laboratories. As BES user facility support grows, a separate budget category for construction and operation will separate and assure that these are recognized and maintained in balance with continuing BES scientific research responsibilities. Thus, I agree with the thrust of the ERAB recommendation.

3. **QUESTION: As you know, the President has proposed constructing the multi-billion dollar Superconducting Super Collider (SSC).**

   a. **What is your view of the project?**

      RESPONSE: It is my opinion and that of the vast majority of scientists at Argonne that the Superconducting Supercollider is a project of major significance, worthy of full commitment from the nation.

b. What impact might it have on funding for other research priorities?

RESPONSE: The effect of the SSC on funding of other research priorities was perhaps best addressed by the ERAB Physics Panel which said in its report, "The panel recommends that the funding for SSC construction be considered in a national context which is larger than that of DOE alone and independent of the four facilities recommended . . . below." The referenced facilities are compact ignition tokamak, the 7-GeV advanced photon source, the relativistic heavy ion collider and the advanced neutron source. Accepting the challenge and the commitment of a project the size of the SSC means that nation must accept its funding as an item separate from the ongoing research budget of the nation. To do otherwise — which is to significantly weaken other aspects of the national science program to support SSC — represents a failure to accept the commitment which the SSC requires.

c. If there was clearly a stark choice between additional funding for academic or National Laboratory research, and construction of the SSC, what choice would you advise this Committee to make?

RESPONSE: I believe that even the most avid supporter of the SSC would not, in good conscience, suggest that additional funding for academic or national laboratory research should be be cut off to accommodate the SSC. Certainly, that would be my opinion.

4. QUESTION: The Committee is often confronted by individuals and groups requesting moneys for research proposals and facilities that have not undergone the normal merit review process. How should the Committee treat such requests? What review mechanisms or policies should be implemented to ensure that taxpayer dollars are being well spent?

RESPONSE: Argonne National Laboratory would be perfectly content if the Committee refused to consider any requests for research proposals or facilities that had not undergone review and comment by scientific and technical leaders in their field. To be effective, that requirement would also have to apply to the House Appropriations Committee and its subcommittees and to the equivalent Senate bodies.

Whether the imposition of such a requirement is politically feasible is a matter which your committee is better able to answer. A second problem would be determining in advance what constitutes a qualified peer review group. We would suggest that a review committee would qualify if it were sponsored by one of the major funding agencies or the advisory committees to those agencies: The Department of Energy, the National Science Foundation, the National Academy of Science, the National Institutes of Health, or a major national professional society.

5. **QUESTION: What is the level of Work for Others (WFO) at your Laboratory, and what percentage is this level of your total laboratory funding?**

   RESPONSE: In FY 1986, Argonne received $45.1 million in new funding authorizations from sponsors other than DOE. These sponsors include the Nuclear Regulatory Commission and Department of Defense, state and local governments, and private organizations and entities, including universities and colleges. This amount represented 18% of the Laboratory's total funding, which includes operating, capital equipment and construction funding. Excluding work for the Nuclear Regulatory Commission, WFO funds for FY 1986 amounted to 16% of the total laboratory operating budget. We estimate that WFO support will be 18-20% of the total laboratory operating budget in FY 1987.

6. **QUESTION: Please comment on the DOE-imposed ceilings regarding the amount of Work for Others at your laboratory. Is the level too high? Too low?**

   RESPONSE: We have received guidance from DOE that an appropriate WFO ceiling for the multiprogram laboratories should be 20% of the individual laboratories' operating budgets, excluding work for the Nuclear Regulatory Commission.

   My general recommendation regarding policy for work for others is that where the laboratories have unique capabilities, well matched to national R&D priorities, these capabilities should be brought to bear on the national problems, subject to the qualification that the research not interfere with work for DOE. This perspective is consistent with a general concept of mine — expressed by others as well — that the laboratories should be regarded as national resources for R&D, capable of serving the nation much as the parts of a corporate laboratory serve a large American firm. For purposes of efficient management and administrative control, the laboratories' first line of accountability must remain with the parent agency.

   The present work-for-others criteria, adopted and implemented by the Department of Energy, are reasonable and effective. With continued adherence to these guidelines, I do not see the need for an inflexible ceiling on work for others.

7. **QUESTION: On January 14, 1987, the Department of Energy promulgated a new regulation (48 CFR Part 970, Acquisition Regulation) prohibiting lobbying by its contractors.**

   a. **Do you believe it is proper for Laboratory Management or staff to approach Congressional Members or staff with proposals for additional funding for new or ongoing programs in the absence of a substantive request for such information? What is the policy of your laboratory in this regard?**

      RESPONSE: I believe it is improper for any employee of the laboratory, as such, to solicit additional funding from members of Congress or their staff for new or on-going programs in the absence of a substantive request for such information. However, provision of scientific and technical information and advice to Congressional contacts, as well as the monitoring and analysis of *legislative activities, I believe are legitimate activities. It may not always be possible to document such requests or responses. Coordination of all official contacts with Congressional members and staff is accomplished by the laboratory through designated senior-level managers at the laboratory.*

b. **One provision in this regulation allows contractors to recover costs responding to congressional inquiries only if written information provided in such response is concurrently furnished to DOE.**

i. **Do you believe this will inhibit you in substantiating orally-transmitted information or providing other written information in response to telephone requests by congressional members and staff?**

RESPONSE: On occasion, the laboratory's technical experts may disagree with advice or guidance issued by a sponsoring agency. To the extent that a frank discussion of such issues is required by Congress, laboratory experts may be inhibited from freely expressing views in writing that directly contradict opinions and views promulgated by the sponsoring agency. This is particularly true when submission of such documentation to the sponsoring agency is linked to the reimbursement of costs.

ii. **What, if any, difficulties, additional costs, etc., do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your laboratory's additional costs because of this requirement?**

RESPONSE: Difficulties in carefully documenting oral requests by Congress for technical information and advice could require the laboratory to increase effort to do so in order to continue its present practice of responding in writing to such requests. Costs for preparation and distribution of such materials to one or more DOE offices concurrently also would increase incrementally. Although congressional requests for information have not been excessive or costly in the past, these added requirements could cost the taxpayer substantially.

c. **Another provision of the regulation limits the recovery of contractor costs incurred in providing written information to congressional staff during oversight visits to the contractor-operated laboratories. Such costs may only be recovered if the contractor provides the information concurrently to the Department of Energy.**

i. **Do you believe this will inhibit you in providing written information to congressional staff?**

RESPONSE: The same concerns, as expressed above, regarding the frank and open expression in writing of scientific views contrary to the *sponsoring agency's position apply to "drop in" visits by members of Congress and staff.*

ii. **What, if any, difficulties, additional costs, etc., do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your laboratory's additional costs because of this requirement?**

RESPONSE: See response to question 7.b.ii.

d. **What, if any, concerns do you have with any other provisions of the regulation?**

RESPONSE: I am unaware of any problems with other provisions of the DOE regulation at this time.

8. **QUESTION: What use do you make of external review groups, other than DOE groups, in evaluating and monitoring your various research programs?**

RESPONSE: Argonne makes full use of the review process established by the University of Chicago to oversee the scientific and technical programs of the laboratory. The university annually convenes separate external committees to review each of the scientific divisions at the laboratory and to report their findings, both in written reports and in person, to the U of C, the Board of Governors for Argonne, the laboratory management, and DOE. In addition, the University and the laboratory have established review and advisory committees for many of its major programs, including the Integral Fast Reactor and the 7-GeV Advanced Photon Source. In all, more than 150 distinguished scientists and engineers are brought to the laboratory each year in conjunction with these reviews. We believe this to be the most rigorous program review process employed at any of the DOE multipurpose labs.

9. **QUESTIONS: What are the major institutional issues facing your laboratory? How are you addressing them?**

RESPONSE: Argonne's institutional issues fall into two broad classes, laboratory research initiatives and administrative matters. Both of these are formally addressed with DOE through the annual institutional planning process that involves submission of preliminary data for the ensuing five year planning period, face-to-face discussion with high-ranking DOE managers at the annual on-site review, and preparation of a formal institutional plan for formal approval by DOE.

Argonne's laboratory research initiatives for the current planning cycle involve research and development on the following topics:

1. *7-GeV Advanced Photon Source and Associated Biomedical X-ray Complex*

2. *Fundamental Chemistry of Energy Processes*

3. *High Temperature Superconductivity*
4. *Biotechnology*
5. *Multi-Phase Flow Research Institute*
6. *Geosciences*
7. *Steel Initiative*
8. *Center for Energy Research Computation*

Laboratory administrative matters concern: timeliness in DOE's providing funding and guidance to ensure continuity of programs, particularly during the first part of each fiscal year; unnecessarily high costs to provide safeguards and security for nuclear materials; increased costs for environmental compliance; decontamination and decommissioning of obsolete or surplus facilities; and adequate support for general plant projects and equipment.

10. **QUESTION: The Energy Research Advisory Board (ERAB) recently issued its report "Geoscience Research for Energy Security." Please comment on each of the four principal recommendations of that report:**

    a. **The DOE should modify its policy and give the highest geoscience research priority to shorter-term, lower-risk options for energy supplies upon which the nation will be primarily dependent for at least the next two decades.**

       RESPONSE: *Argonne was privileged to work closely with the ERAB panel responsible for this report, and with that perspective I am generally supportive of its findings and recommendations. DOE at present lacks a strong focus on geoscience research, particularly regarding fossil energy resources. Yet energy security considerations are dominated by concerns over availability and use of fossil energy supplies, particularly oil and natural gas. Clearly, DOE needs to place a higher research priority on these, especially since industrial R&D in this area has stagnated. DOE should not replace industrial R&D in geoscience, but rather complement it with a program, that, in time, will yield more effective methods of exploration for hydrocarbon resources. For example, fundamental research is needed to improve geological understanding of fossil resources, to develop high-tech geological methods, and to advance geochemical characterization of hydrocarbon resources.*

    b. **Establish in the DOE an Office of Geoscience Research to develop and administer a strategic plan for geoscience research activities within the Department, especially in oil and gas and other liquid hydrocarbon conversion options.**

       RESPONSE: *DOE needs a strong research focus that goes well beyond the loose coordination that presently characterizes the Department's scattered* *geoscience programs. ERAB's call for an Office of Geoscience Research could provide the focus and establish strong scientific integration of many separate activities. I believe the DOE Undersecretary should carefully evaluate all possible organizational options to determine the best functional position for such an Office.*

c. **Establish oil and gas research centers within each of the six major oil and gas provinces of the United States to conduct and coordinate interdisciplinary problem-oriented research in the following areas, all of which mitigate the problem of domestic hydrocarbon supply: enhanced oil recovery, unconventional natural gas recovery, subtle petroleum trap exploration, and geological basin analysis.**

RESPONSE: The proposed centers are a way to involve state geological agencies and academic expertise in addressing region specific problems. It is important that an expanded DOE geoscience program not duplicate or ignore these existing capabilities. The success of the proposed centers will depend upon the sharing of geological information and experience developed by the petroleum industry among the investigators at these research centers. Argonne has no interest in administrating such a center, but our scientists would contribute positively to collaborative research with such centers if they were developed. Again, the Undersecretary should study all options to ensure that the best technical and cost-effective organization is achieved.

d. **Increase oil and gas research funding by an initial annual increment of $50 million, primarily to support the regional research centers.**

RESPONSE: Undoubtedly much can be accomplished through consolidation and program redirection within the Department's geoscience-related programs. ERAB estimates that in FY 1985 DOE's geoscience funding in the energy supply area totalled $88 million, with only $45 million directed to solid-earth sciences. However, $36 million narrowly addresses geothermal resources, which although useful will contribute little to energy security in the next few decades. Clearly, the remainder is inadequate to carry out ERAB's recommendations for a high priority national effort.

11. **QUESTION: Please describe the Strategic Defense Initiative (SDI) efforts you have been and are conducting at your laboratory. What are the actual and estimated SDI funding levels for your laboratory you have received (both DOE and DOD) for each of FY 1987, and FY 1988?**

RESPONSE: Argonne's efforts for the Strategic Defense Initiative (SDI) include research at the Neutral Particle Beam Test Stand (NPBTS), completion of additional experimental facilities at the NPBTS, and research on parallel computing. The laboratory also is developing space nuclear power concepts and related technologies, conducting applied research directed to feasibility questions regarding nuclear reactor driven laser systems, and studying the protection of space assets. The work performed for these last three programs is classified.

Argonne developed and is operating the Neutral Particle Beam Test Stand (NPBTS) in support of SDI leading to an in-space test of an accelerator capable of producing a 50 MeV beam. The NPBTS consists of three beam lines for generation of fundamental beam parameters and component testing. Experiments are currently in progress to test components required for beam shaping, neutralizing, sensing, and steering.

Currently, Argonne is completing design and construction of additional facilities at the NPBTS to conduct integrated, multi-sensor, multi-phenomena discrimination system studies coupling neutral particle beam techniques and data to SATKA Integrated Experiments (SIE). These facilities will enable experiments to be conducted aimed at developing systems that use data in real-time to differentiate between decoys and simulated reentry vehicle targets. Experiments and studies will begin in FY 1987.

Argonne plans to modify the Rapid Cycling Synchrotron (RCS) located at the Intense Pulsed Neutron Source (IPNS) to permit deuteron acceleration and to provide for the extraction of very narrow beam pulses, as required for secondary neutron time-of-flight measurements. Three new experiment facilities will be designed and constructed adjacent to the NPBTS that will make use of both deuteron and proton beams from the RCS. Experiments will begin in FY 1987, with further enhancements to the experimental arrangements to be implemented during FY 1988 and FY 1989.

To meet its objectives, SDI will require leading-edge computer hardware and software. New computer architectures are becoming available, predominantly parallel. They promise to provide highly cost effective performance and, in some cases, performance levels that cannot currently be achieved on any other machine. Both these features are vitally important to the SDI, since successful implementation of any SDI system will require myriad computer systems, some with performance far in excess of what is now available. Recognizing this situation, Argonne is proposing to operate for the SDI a parallel computer research facility, based on Argonne's existing Advanced Computing Research Facility (ACRF), which will conduct research, consulting and technology transfer activities relating to the SDI's advanced computing needs. The funding level for the SDI effort at Argonne for FY 1986 was $10.2 million. For FY 1987 and FY 1988 the laboratory estimates that new funding authorizations will total $16 million and $15.6 million, respectively, including funding from both the DOE and the DOD.

12. QUESTION: What pressing needs of your laboratory are not addressed adequately in the DOE's FY 1988 budget request? What funding would be necessary in FY 1988 to meet these needs and what will be the consequences if these additional funds are not made available?

RESPONSE: *Pressing needs at Argonne is potentially a broad topic. The laboratory has proposed several very important initiatives not yet fully funded in the Administration's budget. The most important of these initiatives is the 7-GeV Advanced Photon Source, for which complete preconstruction R&D will require* *funding of $11 million in FY 1988, rather than the $5.5 million in the Administration's budget request. Argonne's request of $11 million will ensure readiness for a full-scale start of construction in early FY 1989. There is intense international competition in the technological areas that the 7-GeV APS will support, and availability of the full $11 million will be particularly beneficial to our nation. Other Argonne initiatives were identified under Question 9. Shortfalls in their funding by DOE for FY 1988 also implies loss of important scientific and technological opportunities for the United States.*

Argonne also has a number of pressing needs with regard to site environmental issues, such as decontamination and decommissioning of obsolete radioactive facilities. However, funding requests in future years for solutions to these problems are being coordinated with DOE, so I will not discuss them here.

I will take this opportunity to highlight two major laboratory programs for which the Administration's budget request would cause very immediate, serious difficulties: The Liquid Metal Reactor Program, and the ATLAS Accelerator Facility. Both programs have been extremely successful, and widely recognized as such. Both programs represent major national investments whose exploitation already has built great momentum. Unfortunately, both programs also are threatened with inadequate operating funds, which would disproportionately reduce their productivity and their service to the nation.

LMR PROGRAMS (INCLUDING IFR) — OPERATING FUNDS

FY 1988 Budget Requests:

	Operating Expenses			
	for Advanced Reactor R&D	*for Facilities*	*Plant & Capital Equipment*	*TOTAL*
Argonne:	*$24.0 M*	*$44.1 M*	*$9.1 M*	*$77.2 M*
Administration:	*$19.0 M*	*$34.1 M*	*$9.1 M*	*$62.2 M*
Shortfall:	*$5.0 M*	*$10.0 M*	*0*	*$15.0 M*

Argonne's Liquid Metal Reactor (LMR) Program consists of (1) the Integral Fast Reactor (IFR) development program, (2) LMR base technology programs, and (3) Argonne-West Facilities. The IFR has the potential to provide our nation with a virtually inexhaustible source of electric power, at competitive costs and with inherent safety vastly more assurable than for existing reactors. Tests at EBR-II already have shown that metal-fueled liquid-metal-cooled reactors like the IFR will shut themselves down in circumstances like those that have caused the most severe problems at existing reactors. Other tests have shown that metallic fuel for the IFR will provide a large amount of power before requiring reprocessing, and that the IFR's very compact on-site reprocessing technology is feasible at the pilot *scale. Companies designing innovative liquid-metal reactors for DOE — General Electric and Rockwell International — have incorporated major features of the IFR into their designs. The IFR Program now generally is recognized as the centerpiece of DOE's Advanced Reactor Program.*

Despite the spectacular success of IFR development over the past three years, the Administration's FY 1988 budget request recognizes the program's needs only incompletely, seeming in effect to be pulling in different directions at the same time. The Administration's budget appropriately provides $5.5 million (in Plant and Capital Equipment funding) for reactivation of the Fuel Cycle Facility required for further IFR demonstrations. However, incongruously, the Administration's budget provides $10 million less than is needed for operating expenses.

Also of great concern is Argonne's LMR base technology program, the backbone of IFR development. The Administration's budget eliminates all support for this base program in reactor systems and core systems.

Argonne needs critically an additional $15 million in operating funds, beyond amounts provided in the Administration's FY 1988 request, $5 million for Advanced Reactor R&D and $10 million for Facilities. Failure to provide $5 million for the LMR base technology program would eliminate the only complete capability in advanced reactors at a national laboratory. Failure to provide $10 million for operation of Facilities would disrupt the whole program severely, disproportionately reducing its productivity and hamstringing efforts to demonstrate further the promise of the IFR concept.

ATLAS ACCELERATOR FACILITY — OPERATING FUNDS

FY 1988 Budget Requests:

Argonne:	*$8.316 M*
Administration:	*$7.460 M*
Shortfall:	*$0.856 M*

ATLAS is the world's first superconducting accelerator for heavy ions. It was completed, on schedule and within budget, during FY 1986, and it has quickly become the premier facility in the world in its designed energy range. ATLAS provides extremely precise heavy-ion beams for high-resolution nuclear research. Its energy level is easily variable, and its beams have exceptional quality (very sharp definition in energy and in time). Demand for beam-time by researchers (the majority from universities) currently exceeds availability by a factor of approximately 2.5.

Despite the great success of ATLAS, and despite the substantial investment represented by its construction, the Administration's FY 1988 budget request would reduce significantly the operating time and the support services that ATLAS could provide. Reductions in manpower would be inevitable, and overall utilization of

ATLAS could be only about 60 percent of what would be permitted by operating funds equal to those received in the first year of its operation (FY 1985). Currently, by stretching resources extremely thin, Argonne is able to operate ATLAS 5.5 days per week. Argonne's budget request for FY 1988 would allow ATLAS to operate around the clock, seven days a week, and would eliminate significant inefficiencies due to inadequate support for users. As the premier nuclear physics facility of its type in the world, whose scientific productivity is greatest in its earliest years, ATLAS deserves no less.

As specified in Question 12, the focus of the above remarks has been on the shortfall in the Administration's budget relative to Argonne's request. However, these remarks also should make clear the disproportionately greater damage to ATLAS's productivity that would be caused by any level of funding below that proposed by the Administration, such as some Congressional committeemen have suggested.

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Office of the Director

April 22, 1987

The Honorable Manuel Lujan, Jr.
U.S. House of Representatives
Committee on Science, Space
  and Technology
Suite 2321
Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Lujan:

As you requested, enclosed are my responses to the questions from the Subcommittee on Energy Research and Development.

If I can be of any further help, please do not hesitate to contact me.

Sincerely,

N. P. Samios

N. P. Samios
Director

Enclosure

RESPONSE TO QUESTIONS OF THE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
MARCH 18, 1987

1. **One of our earlier witnesses, Dr. Robert Hansen, Director of Ames Laboratory, testified that he perceived that the DOE now has a facilities focus rather than an energy focus. Do you believe this to be the case, and if so, do you think this change in focus is appropriate?**

   DOE is responding to the scientific community in recommending new facility construction in the coming years. As I have testified this involves a delicate balance between maintaining and supporting the ongoing program and initiating new exciting projects. In general this is a difficult task and DOE is doing a reasonable job. The problem with energy policy is its oscillatory nature. It varies with Agency (ERDA, DOE) and Administration (Carter, Reagan) and the national laboratories are in the unenviable position of having to respond, at short notice, to changing policies. A consistent, long term, agreed upon national energy policy is clearly desirable.

2. **The December 1985 Energy Research Advisory Board report on "Guidelines for DOE Long Term Civilian Research and Development" recommended that the BES budget should establish a "separate budget category for facilities construction and operation". Do you agree with this recommendation?**

   We believe tht a separate Congressional budget category for facilities construction and operation is not advisable. The balance between these activities and the research programs is a delicate one and flexibility in making this balance is necessary. We provide to DOE detailed forecasts of funding requirements for our facilities, and we keep these up-to-date. We believe that this is a proper mode of operation.

3. **As you know, the President has proposed constructing the multi-billion dollar Superconducting Super Collider (SSC).**

   a. What is your view of the project?

   b. What impact might it have on funding for other research priorities?

   c. If there was clearly a stark choice between additional funding for academic or National Laboratory research, and construction of the SSC, what choice would you advise this Committee to make?

   a. As noted in my testimony before the Subcommittee, I believe that the Administration's decision to build the SSC is a positive, ambitious and an important step in the field of particle physics... a necessary expansion into the multi TeV energy range.

b. This is a critical aspect of the project. One is faced with the important ongoing programs and creating new facilities for the future. It is vital that during the construction phase of a multi-billion dollar project the funding required be "add on" monies. When the new research complex is completed as has historically been the policy in this field, facilities not at the cutting edge are shut down. This is a sound procedure which I support.

c. I believe this to be a non-question. In order to have qualified personnel to use the SSC when it is completed, one has to have supported the ongoing program (academic and national lab research) during the intervening years. If not there will be no one (in the US) to exploit such a forefront facility. If on the other hand the SSC is not funded, then it will signal the start of the demise of particle physics in the US.

4. **The Committee is often confronted by individuals and groups requesting moneys for research proposals and facilities that have not undergone the normal merit review process. How should the Committee treat such requests? What review mechanisms or policies should be implemented to ensure that the taxpayer dollars are being well spent?**

It is my opinion that research proposals and facilities require the support of the appropriate scientific community before being implemented. For the DOE this usually involves HEPAP, NSAC, BESAC and other panels. Difficulties have arisen in recent years, mainly among universities involving building facilities, for which normal mechanisms for their funding are less than adequate. As such several such projects have been proposed not through the usual procedures but via the political route. There is a need for some mechanism to take care of such needs, i.e. scientific building for universities, and separate funds either in the NSF or DOE should be set aside for such purposes with proper review procedures.

5. What is the level of Work for Others at your Laboratory, and what percentage is this level of your total laboratory funding?

BROOKHAVEN NATIONAL LABORATORY

WORK FOR OTHERS	Fiscal Years ($ in Millions)		
	1986	1987	1988*
TOTAL BNL OPERATING FUNDS	$201.6	$211.0	$212.3
Work for Others			
Nuclear Regulatory Commission	$17.3	$ 17.1	$ 16.7
DOD-Strategic Defense Initiative	6.6	10.6	7.6
All Other	21.2	20.8	19.6
TOTAL	$45.1	$ 48.5	$ 43.9
Percent of Operating			
Nuclear Regulatory Commission	8.6%	8.1%	7.9%
DOD-Strategic Defense Initiative	3.3	5.0	3.6
All Other	10.5	9.9	9.2
WFO - Non NRC	13.8%	14.9%	12.8%
TOTAL WFO	22.4%	23.0%	20.7%

*Based on President's Budget

6. Please comment on the DOE-imposed ceiling regarding the amount of Work for Others at your laboratory. Is the level too high? Too low?

The DOE-imposed ceiling is 20% of our total operating funding for the year excluding work for the Nuclear Regulatory Commission.

As you can see from the answer to Question 5, BNL is within this guideline. We are cognizant of DOE's concern that the overall level of effort devoted to research and development Work for Others at an installation should be limited, as necessary, to assure that the DOE facilities and personnel required for efficient and effective execution of DOE's mission programs are available. It should be noted that the national laboratory system has proven its ability to quickly adapt to changing national needs with its multi-disciplined scientific staff. This is a national resource which should be optimized to the maximum extent practical. Given BNL's current level of activity in the WFO area, we feel the 20% guideline imposed by DOE is reasonable and allows us the flexibility to use our expertise to assist others as the need arises.

7. On January 14, 1987, the Department of Energy promulgated a new regulation (48 CFR Part 970, Acquisition Regulation) prohibiting lobbying by its contractors.

   a. Do you believe it is proper for Laboratory management or staff to approach Congressional Members or staff with proposals for additional funding for new or ongoing programs in the absence of a substantive request for such information? What is the policy of your laboratory in this regard?

   7a. No. It is DOE and lab policy to only respond upon a substantive request for information.

   b. One provision in this regulation allows contractors to recover costs responding to congressional inquiries only if written information provided in such response is concurrently furnished to the DOE.

      i. Do you believe this will inhibit you in substantiating orally-transmitted information or providing other written information in response to telephone requests by congressional Members and staff?

      ii. What, if any, difficulties, additional costs, etc., do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your laboratory's additional costs because of this requirement?

   7b. (i) No. (ii) Costs are not a major difficulty, nor are there any other major difficulties.

   c. Another provision of the regulation limits the recovery of contractor costs incurred in providing written information to congressional staff during oversight visits to the contractor-operated laboratories. Such costs may only be recovered if the contractor provides the information concurrently to the Department of Energy.

      i. Do you believe this will inhibit you in providing written information to congressional staff?

      ii. What, if any, difficulties, additional costs, etc., do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your laboratory's additional costs because of this requirement?

   7c. (i) No. (ii) None and minor costs.

d. What, if any, concerns do you have with any other provisions of the regulation?

7d. None.

8. **What use do you make of external review groups, other than DOE groups, in evaluating and monitoring your various research programs?**

The Laboratory has as a matter of policy used external (non DOE) review committees to evaluate and monitor our research programs. These committees are appointed by Associated Universities. Their findings are submitted both as an oral summary and a written document to AUI. In addition there are other external review groups that are appointed to critically review major construction facilities very early in the conceptual design stages. The Laboratory also has committees with substantial external participation to approve and subsequently monitor experiments proposed for the various research facilities at Brookhaven.

9. **What are the major institutional issues facing your laboratory? How are you addressing them?**

The major issues involve timely construction of major forefront research facilities. These are the AGS Booster (under construction), Phase II of the NSLS (just completed), RHIC (proposed for construction in FY'89), and the HFBR Guide Hall and Phase III of the NSLS. These projects are in the two major thrust areas of the laboratory, namely, High Energy-Nuclear Physics and Basic Energy Sciences. In order to implement the construction of such machines, we have discussed and received support from our user groups, AUI Trustees, National DOE Advisory Committees and finally DOE. Our frustration is implementing them on a proper time scale.

10. **The Energy Research Advisory Board (ERAB) recently issued its report "Geoscience Research for Energy Security". Please comment on each of the four principal recommendations of that report:**

   a. The DOE should modify its policy and give the highest geoscience research priority to shorter-term, lower-risk options for energy supplies upon which the nation will be primarily dependent for at least the next two decades.

   b. Establish in the DOE an Office of Geoscience Research to develop and administer a strategic plan for geoscience research activities within the Department, especially in oil and gas and other liquid hydrocarbon conversion options.

   c. Establish oil and gas research centers within each of the six major oil and gas provinces of the United States to conduct and coordinate interdisciplinary problem-oriented

research in the following areas all of which mitigate the problem of domestic hydrocarbon supply: enhanced oil recovery, unconventional natural gas recovery, subtle petroleum trap exploration, and geological basin analysis.

d. Increase oil and gas research funding by an initial annual increment of $50 million, primarily to support the regional research centers.

We fully concur with the need to strengthen and give greater focus to research for geoscience. On 2/7/85 Dr. S. Baron, Associate Director responsible for Applied Programs at Brookhaven National Laboratory, testified before the Energy Research Advisory Board Panel and urged greater support for geoscience research. We are pleased that ERAB has endorsed our recommendatons. We also believe in response to Item a), that DOE should modify its research priority in geoscience to support shorter-term, lower risk options for energy supplies necessary for the next two decades.

There is no question that energy supply will be a national problem. It is only a question as to when and at what price to the consumer. Clearly a well planned national geoscience research program will benefit our development of energy supplies. However, it is also clear that pouring large sums of money into solving a problem will not assure its success. There are many lessons learned by this nation's response to the 1973 oil crisis and we should draw on this experience before committing large funds to costly programs that have been identified as Items c) and d) above. During the 1973-1983 period, the United States funded many new energy supply technologies only to find them unlikely alternatives even though they were technological successes. Typical examples have been the efforts to develop MHD with extensive funding in both Tennessee and Montana, the large high BTU synthetic gas project in North Dakota, and the Barstow, CA solar thermal power plant. These projects were heavily funded at a great cost to the government and yet demonstrated no economic possibilities. Many other projects were cancelled such as the oil shale development in light of the uneconomic possibilities.

On the other hand, we believe that funding for the geosciences should be directed to research that characterizes the nature of the various hydrocarbons and thereby permitting us to better understand the formations and the location and the quality particularly as it is related to our geological history. Increasing our knowledge of the basic sciences of hydro-carbon will also permit us to develop economic processes for the exploration, extraction and processing. We believe that an office of geoscience research (Item b) under the direction of the Assistant Secretary of Energy Research, would serve to give the geoscience program the appropriate management and permit its interrelationship with the other basic sciences in the Office of Energy Research.

11. **Please describe the Strategic Defense Initiative (SDI) efforts you have been and are conducting at your laboratory. What are the actual and estimated SDI funding levels for your laboratory you have received (both DOE and DOD) for each of FY 1986, FY 1987, and FY 1988?**

BNL has two major facilities in connection with the SDI Program and we also undertake research and studies in advanced reactors for space programs and proposals in connection with the SDI program. One major facility at Brookhaven is the Radiation Effects Facility (REF) ($4.3 million) which is now completed and is utilized by the SDI community to undertake the testing of computers and electronic equipment in a radiation atmosphere anticipated in space.

We are now completing a second facility called the Neutral Beam Test Facility (NBTF) ($12.8 million) which will undertake research in beam sensing and beam neutralizing in connection with the SDI program. This facility will be completed and in operation by 1988.

The third effort is the development of a particle bed reactor which is a compact power source that will permit space propulsion and space power if a multi-megawatt power unit is required in the space program. Our work in this area is strictly related to studies and investigations and does not include any nuclear reactors at Brookhaven National Laboratory for this activity. We will not have any reactors of this nature at BNL should there be an interest in proceeding with the program.

The budget for the SDI effort supported by DOD funding of the REF and NBTF and particle bed studies is as follows:

Fiscal Year	($ in Millions)	
1986	1987	1988
$6.6	$10.6	$7.6

The newly constructed REF at BNL provides the means to generate the data base for discrimination of neutral particle beams. One particular part of the needed data base is the investigation of the vacuum-ultraviolet (VUV) emission from surfaces that is produced by these particles. This program supported by DOE funds will use the REF facility and existing VUV spectrophotometric equipment to investigate the possible use of VUV emission from proton-irradiated surfaces as a possible discrimination signature.

The funding for this SDI effort supported by the DOE is as follows:

Fiscal Year	($ in Millions)	
1986	1987	1988
0	$0.3	$0.3

12. **What pressing needs of your laboratory are not addressed adequately in the DOE's FY 1988 budget request? What funding would be necessary in FY 1988 to meet these needs and what will be the consequences if these additional funds are not made available?**

The projected budget for the AGS will only allow a 12-14 week operations period which is less than half of its capability. Additional funding of $7.4M would add 13 weeks of operation so that some already delayed experiments can be accommodated.

The funding for the AGS booster project has been less than desired. We currently see a pattern of $2M (FY'86), $2.5M (FY'87) and $8.3M (FY'88) leading to a delayed schedule and ultimately to increased costs for project completion.

I would also urge support for increased funding in the nuclear physics FY'88 budget for both RHIC and CEBAF. Increased R&D funding for RHIC would assure the readiness of a FY'89 construction start for this exciting and innovative facility.

13. **Are you able to accommodate additional researchers at the High Flux Beam Reactor (HFBR) as a result of the shutdown at HFIR, and if so, what additional operating funds will be required for FY 1987 and FY 1988?**

We have already made accommodation for a number of additional researchers at the HFBR as a result of the HFIR shutdown. Only a modest expansion of this accommodation is possible if we do not reduce running time for each experiment excessively. Only modest increases in operating costs (the addition of one or two staff scientists to assist the users) is necessary for these limited expansions. A considerable increase in our ability to accommodate new researchers would be possible when our Mini-Guide Hall for the HFBR is authorized. This has been proposed in the past and been given highest priority by the Seitz/-Eastman review of several years ago. Funding for this project is imperative if HFIR is shut down for an extended period.

14. **What is the proposal you have for further improvements to the National Synchrotron Light Source (NSLS)? What is the proposed schedule and cost through project completion?**

Both storage rings at the NSLS are supporting very active experimental programs. The Phase II construction project for insertion device source development has been successfully completed on the VUV-Ring, with completion scheduled in the fall of 1987. Performance of the NSLS storage rings is presently limited by an inadequate injection system, and we have submitted a proposal for a new injection system. This proposal is for $38,000,000, with a proposed start date of October 1989 and a duration of three years. The new injection system will provide high injection rates, greater reliability, the use of positrons, rather than electrons, for improved lifetime and stability and the basis for a future short wavelength free electron laser program. It will optimize for users the reliability and lifetime of the beams.

15. **Several synchrotron installations in the Nation provide a base for a strong U.S. semiconductor industry thrust in x-ray lithography. Please supply the following information:**

a. **What are the critical elements of a synchrotron system for use in x-ray lithography?**

The following factors are essential for a synchrotron-based x-ray lithography source:

i. magnets and associated power supplies
ii. vacuum, system
iii. rf system
iv. injection system
v. controls and diagnostic system
vi. beamline interface hardware
vii. cryogenic system if superconducting magnets are used

b. **What centers and/or pockets of expertise exist in the U.S. which might be tapped as a national resource?**

Synchrotron radiation expertise can be found at the following institutions:

i. National Laboratories, especially BNL, LBL, FNAL, SLAC, and ANL
ii. Cornell U.
iii. Stanford U.
iv. Texas Accelerator Center
v. SRC at Wisconsin U.
vi. a few small business firms with accelerator expertise in-house

c. **What is unique about Brookhaven's capability as opposed to the expertise that exists at the SSRL, LBL, ANL, and the SRC?**

Brookhaven has completed and successfully operates the NSLS which is a world-class dedicated light source facility. It has interfaced to the IBM x-ray lithography program which is, by far, the most successful x-ray lithography program in the U.S. The Laboratory is experienced in handling large projects and interactions with outside institutions. The NSLS staff is complete and is not overcommitted to other projects and has been working with industry for over a year to formulate borad plans for an x-ray lithography project.

16. **What are the technical barriers, if any, and engineering challenges to be solved in building a synchrotron suitable for use on a semiconductor production line? Please discuss these for both (a) conventional and (b) cryogenic approaches.**

An electron synchrotron tailored to produce the optimal x-ray spectrum for lithography can be built with a straightforward extension of today's technology. Technological difficulties common to both conventional and cryogenic machines, which must be dealt with in designing a lithography source, are:

1. Diagnostics and control system: To achieve a 95% up-time in a production line environment without constant supervision by highly trained physicists and engineers, requires an extremely advanced level of computer control, including self-diagnosis capability and the use of so-called "expert programs".

2. Injection: A compact injector implies a low-energy (and low cost) injector, and consequently difficulties to inject and store high currents at low energies. This requires some development and study before finalizing design.

A major technical barrier for the cryogenic approach is the marrying of a set of superconducting magnets to a successful synchrotron. Although it may be feasible to construct a cryogenic magnet at this time, a set of magnets of the necessary specification have not been produced anywhere in the world.

17. **How will BNL transfer its expertise in synchrotron technology to the equipment manufacturing industry so that this industry can effectively serve the needs of the semiconductor industry?**

BNL will transfer its synchrotron technology experience to industry by several methods:

Working closely with component and systems manufacturers to achieve workable industrial systems.

Inviting firms who will be responsible for designing and producing production model storage rings to have key personnel participants in key steps in the design, production and commissioning of the prototype ring.

Making all design data for the prototype ring available to U.S. industrial firms.

18. **How will the construction of a conventional synchrotron at the BNL site in the same energy regime as the LBL 1-2 GeV Synchrotron Light Source enhance U.S. industry's manufacturing capability?**

A machine designed for industrial x-ray lithography has a unique set of performance and physical characteristics. Industry needs a machine which is small in size for distribution into a factory environment, low in cost so that it is commercially viable, and that has an x-ray beam size, intensity, and photon energy distribution which is matched to the lithography process. The machine proposed for construction would be a prototype for an industrial machine and has a performance envelope to match the industrial needs, while the LBL machine is a next generation machine for research applications. The lithography machine would also be built largely by industry.

19. **How would BNL draw upon other laboratories and research centers for a more effective technology transfer?**

BNL has recognized that the x-ray lithography program would require collaborative efforts between government, industrial and university laboratories. Three workshops held at Brookhaven drew heavily upon the expertise of these groups. In the future, BNL will concentrate more on the relationship with other laboratories for current data which in turn will be transferred to industry as discussed above in Question 17.

20. **What are the intermediate milestones (tasks and schedules) for establishing an industrial capability for the cryogenic synchrotron? Please name the players and discuss the role of each.**

As described in the third workshop (BNL 52046), the construction of superconducting magnets would proceed in three steps:

Design: This step would be a collaboration between laboratory and industrial personnel.

Model Construction: A series of models would be constructed in industry. Laboratory personnel would assist in verifying performance and interpreting field quality measurements. It is assumed that after one or two iterations, a magnet of suitable performance characteristics would be available.

Prototype Construction: From experience gained in the model program, a pair of prototype magnets would be constructed in industry for incorporation into a compact ring. All other components of that machine would be constructed in exactly the same manner as described in the conventional machine. Laboratory personnel would assist with completion and commissioning of the machine as needed.

This mode of procedure guarantees that, on completion of the prototype machine, the technology would exist in industry to produce additional machines in industry with minimal laboratory involvement. So far, four firms have been identified as capable of construction the magnets with a plan of this nature.

21. **The end user for synchrotron development is the semiconductor industry. Please discuss competing lithography approaches and competing x-ray sources for x-ray lithography. How will increased resist sensitivities affect industry choices?**

There are four approaches to submicron lithography: optical, electron beam, ion beam and x-ray. Optical even with excimer lasers runs out at .5-.7 μm. Electron and ion beam direct write are slow and not cost effective for batch runs. Masked ion beam technology suffers mask survival problems. Increased resist sensitivities would not change the preference for x-ray lithography because it is not the dominant rate limiting process. Plasma x-ray sources will provide interim sources, but exposure times are more than an order of magnitude longer than for synchrotron sources.

22. **What is the industry timetable for acquisition of a synchrotron for pilot line use and for production?**

The consensus of participants at our workshop strongly endorsed a dual program of first producing a room temperature synchrotron as soon as reasonably possible to be used as an advanced development tool by industry. Concurrently, work on research and development for a cryogenic magnet synchrotron that could lead to a prototype for a next generation machine. Present plans call for completion of a pilot warm storage ring 2.5 years after funding.

23. **What features of a synchrotron does industry consider most important? Please discuss trade-offs which the semiconductor industry will make such as capital investment, size, technical staffing, machine reliability and availability, etc., and how these factors affect the evolution of the market for synchrotrons and the ultimate machine configuration.**

Important criteria for industrial machines are reliability, cost and size. Other relevant issues concern shielding and service. Industry would rather pay for a turn-key reliable machine than technical staff.

The features of synchrotron radiation which are important to the lithography process are:

i. the spectral distribution characterized by the "critical wavelength"
ii. the intensity
iii. the parallelism of the radiation and small source size
iv. stability of the source point location

The features desired of the industrial synchrotron are:

i. reliability, 95% uptime
ii. ease of operation, "turn-key"
iii. small footprint and some degree of portability
iv. minimal radiation exposure to staff
v. cost

Reliability and the source characteristics are the primary requirements. In particular, in the near time frame the reliability requirement may favor a normal conducting machine with on-energy injection. On the other hand, footprint and cost tend to favor a superconducting machine. Cost also favors injection at as low an energy as possible.

24. **What industry capabilities in synchrotron fabrication vis-a-vis Japan are required for the U.S. to be competitive in the 1992 time frame?**

U.S. industry has or could develop the expertise to produce synchrotron components for production units by 1992. Industry has comparable experience in fabricating magnetic, ultra-high vacuum and r.f. system components. However, there are areas such as accelerator physics, control and diagnostics storage ring commissioning and systems integration where industry has limited capabilities at this time. Japanese industry has similar problems which are being addressed by assignment of key personnel from industry and laboratories to working groups, each responsible for the six x-ray storage ring projects now underway.

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April 27, 1987

Congressman Manual Lujan, Jr.
Ranking Republican Member
Committee on Science, Space and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Lujan:

In Dr. Shirley's absence from the Laboratory, I am pleased to respond on his behalf to your questions arising from the multiprogram laboratories hearing on March 18, 1987. Many of these answers will reflect Dr. Shirley's testimony at that hearing.

If you require any further information, please let us know.

Sincerely,

Gerd M. Rosenblatt
Deputy Director

Enclosure

cc: Associate Directors

Question 1. One of our earlier witnesses, Dr. Robert Hansen, Director of Ames Laboratory, testified that he perceived that the DOE now has a facilities focus rather than an energy focus. Do you believe this to be the case, and if so, do you think this change in focus is appropriate?

The Department of Energy and its predecessor agencies have a long history of supporting large-scale facilities to implement the scientific and engineering goals of its research and technology programs in energy and national security. The national laboratories have been a major resource for the development, design, construction and operation of such facilities. Further, these facilities have been the focus of much of the multidisciplinary, team approach to research that distinguishes the national laboratories from other research performers.

The change noted by Dr. Hansen is less an emergence of a facilities focus in the Department but rather the fact that the new proposed facilities - that are to serve the entire U.S. scientific community - are almost exclusively in the Department's basic research programs rather than its energy technology programs. This has been the result of the present Administration's commitment to basic research, its recognition of the Department of Energy's strength in scientific facilities, and its policy stance with respect to private sector development of energy technologies. Though DOE has been given the major responsibility for these new Federal scientific facilities it is to be hoped that the significant increases in science support at NSF will be coordinated to enhance the use of DOE's facilities by the broad scientific community.

Question 2. The December 1985 Energy Research Advisory Board report on "Guidelines for DOE Long Term Civilian Research and Development" recommended that the BES budget should establish a "separate budget category for facilities construction and operation." Do you agree with this recommendation?

The ERAB recommendation for facility construction is essentially met by the requirement for line item authorization and appropriation of new DOE projects. In our experience with DOE, a separate budget category for facilities operation has no clear benefit for program management and effective facility utilization.

Question 3. As you know, the President has proposed constructing the multi-billion dollar Superconducting Super Collider (SSC).

a. What is your view of the project?

Dr. Klaus Berkner, Associate Director and Head of LBL's Accelerator and Fusion Research Division, was asked these same questions following his February 25, 1987 testimony before the subcommittee. Dr. Berkner's answer to these questions reflected the viewpoint of the Laboratory management and are repeated here.

The SSC will provide an essential tool in mankind's continuing exploration of the fundamental properties of matter and energy, and I believe that such a quest is intellectually exciting.

b. What impact might it have on funding for other research priorities?

A project of the scale and significance of the SSC must be judged on its intellectual merits and, if deemed worthwhile, should be supported as a separate entity—an add-on to the existing base of scientific support.

c. If there was clearly a stark choice between additional funding for academic or national Laboratory research, and construction of the SSC, what choice would you advise this Committee to make?

Academic and National Laboratory research is at the core of this country's thrust in basic research, advanced technology development, and perhaps most importantly, our training of the next generation of scientists, engineers and technologists. Although the SSC will undoubtedly contribute in these vital areas, the broad emphasis of the academic and National Laboratory research programs and their strengths in a wide variety of critical areas of science and technology must be preserved and enhanced if the United States is to maintain technological leadership in the 21st century. Major new scientific initiatives, such as the SSC, should be considered in this framework.

Question 4. The Committee is often confronted by individuals and groups requesting moneys for research proposals and facilities that have not undergone the normal merit review process. How should the Committee treat such requests? What review mechanisms or policies should be implemented to ensure that taxpayer dollars are being well spent?

Federal mission agencies such as the DOE have established and proven methods for identifying key research that is relevant to their missions. Merit review is a key component of these methods for research project selection. Proposed scientific and engineering programs and facilities that are requested independently of agency planning and review processes are best referred to the appropriate agency for independent assessment prior to inclusion in agency appropriations. External review, such as that addressed in response to question 8, is an essential check on congressional, agency, and laboratory decisions in the research project selection process. These informal and flexible mechanisms have proven to be extremely effective. They should not be replaced with strict procedures that appear to provide greater accountability but could instead impede scientific creativity as well as effective implementation of agency missions.

Question 5. What is the level of Work for Others at your Laboratory, and what percentage is this level of your total laboratory funding?

Work for others is estimated at $30.8M for FY 1987. This represents 16.4% of total funding.

Question 6. Please comment on the DOE-imposed ceilings regarding the amount of Work for Others for your laboratory. Is the level too high? Too low?

The Laboratory chooses its Work For Others (WFO) carefully with the following criteria in mind:

- The research addresses an important national need;
- Unique Laboratory skills or facilities are required;
- The research complements major laboratory programs;
- The research will not adversely impact DOE's or the Laboratory's missions and programs.

Examples of important work for others can be found in the Laboratory's accelerator programs, biomedical programs, superconducting magnet development programs, materials science programs, and conservation and geothermal activities. WFO research is a prime opportunity for technology and information transfer that can lead to increased national economic competitiveness.

The Laboratory's current total WFO levels are below the DOE's arbitrarily set ceiling of 20%. In some Laboratory Divisions, that percentage is considerably higher, however, and the Laboratory receives close scrutiny for these perceived irregularities. Thus, the Laboratory has difficulty in principle with the concept of quantitative ceilings that are used to second-guess Laboratory management decisions at a detailed level. Further, the Department's procedures for WFO are cumbersome and time-consuming and can be potentially discouraging especially for industrial sponsors.

Question 7. On January 14, 1987, the Department of Energy promulgated a new regulation (48 CFR Part 970, Acquisition Regulation) prohibiting lobbying by its contractors.

a. Do you believe it is proper for Laboratory management or staff to approach Congressional Members or staff with proposals for additional funding for new or ongoing programs in the absence of a substantive request for such information? What is the policy of your laboratory in this regard?

While the Laboratory has no specific written policy in this area at present, it is considered appropriate for employees to provide scientific and technical information upon request to its sponsors. This information could include presentations on the scientific and technical achievements of the programs as well as the ramifications of budgetary changes on those programs.

b. One provision in this regulation allows contractors to recover costs responding to congressional inquiries only if written information in such response is concurrently furnished to the DOE.

i. Do you believe this will inhibit you in substantiating orally-transmitted information or providing other written information in response to telephone requests by congressional members and staff?

Since these regulations are new, we do not have any clear evidence; however, any impediments to the free flow of information are likely to be undesirable. Many requests to Laboratory staff are for technical and scientific information that could support differing policy positions. When Congress and the Executive Branch disagree on policy matters, providing information concurrently to both Congress and the Department of Energy may inhibit a discussion of program options.

ii. What, if any, difficulties, additional costs, etc., do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your laboratory's additional costs because of this requirement?

Since these regulations are new, we have no experience on which to base any cost estimates. We would anticipate, however, that providing written information already prepared in response to a Congressional request would add little cost. It could be extremely difficult and potentially costly, however, to make sure that all oral discussions are accurately documented and transmitted to the Department.

c. Another provision of the regulation limits the recovery of contractor costs incurred in providing written information to congressional staff during oversight visits to the contractor-operated laboratories. Such costs may only be recovered if the contractor provides the information concurrently to the Department of Energy.

i. Do you believe this will inhibit you in providing written information to congressional staff?

One of the main reasons that Congressional members and staff have mentioned that they visit the national laboratories is to hear about the scientific and technical programs from the laboratory employees themselves without interpretation from the Department of Energy. The oral, face-to-face and laboratory visit portions of these trips are key elements in useful communications. Concurrently providing written information to the Department may discourage such information from being provided.

ii. What, if any, difficulties, additional costs, etc., do you anticipate due to this requirement? What would you estimate the additional cost to the taxpayers as a result of your laboratory's additional costs because of this requirement?

Since this written information will have already been prepared, supplying the Department with a copy should not be much of an additional cost.

d. What, if any, concerns do you have with any other provisions of the regulation?

A major concern with the new regulations is in Section 970.3102-7(b)(1), which disallows the costs of providing factual, technical and scientific information presented in an informal manner unless requests for this information are made through the Department of Energy. Requests are often made directly to the Laboratory because a Congressional staff member would like to receive factual information informally. The required formal request procedure would greatly reduce, if not eliminate, these informal presentations.

Question 8. What use do you make of external review groups, other than DOE groups, in evaluating and monitoring your various research programs?

The Laboratory recognizes the need for external review and uses expert review and analyses where appropriate. It is the policy of the Laboratory to have an annual external review of the scientific and administrative units. Review boards are composed of distinguished scientists from relevant research fields, representatives from universities, industry, and other national laboratories. Reviews are used to assist in guiding management in determining the quality, structure, efficiency, and appropriateness of divisional programs.

Special review boards are also used. Semiannual reviews of LBL management for the University of California are made by the Scientific and Educational Advisory Committee composed of distinguished representatives from universities, industry, and other DOE laboratories. Other special review boards provide evaluation and recommendation for optimal organizational structures and promising scientific opportunities. For example, the Laboratory has conducted a review of lattice designs for its Advanced Light Source. The valuable input from all these review groups helps to assure that maximum benefit is obtained from the research funded at LBL.

Question 9. What are the major institutional issues facing your laboratory? How are you addressing them?

The principle institutional issues facing the Laboratory are: (1) support for forefront scientific initiatives in the face of limited federal funds; and (2) rehabilitation and renewal of the physical plant.

Scientific Initiatives. New scientific initiatives will require increasing support from limited capital and operating budgets. In conjunction with defined national research program areas, LBL is proposing sixteen initiatives in the general sciences and energy sciences for FY 1988 and FY 1989. As examples, these initiatives include an upgrade to the Bevalac, a Human Genome Center, an Induction Linac Systems Experiment for heavy ion fusion research, a new superconductor research program, a Center for Isotope Geosciences, a two-beam accelerator and a new radon research program. A fundamental challenge to the Department of Energy, and to LBL management, is the acquisition and allocation of research resources to realize the promise of these new initiatives while sustaining worthy existing research programs. This issue is being addressed through careful program planning in conjunction with DOE management, and through phasing out research programs that have accomplished their research objectives. At issue, however, is the provision of increased support for DOE's scientific initiatives so that ongoing quality research programs can be maintained while new programs begin.

Facilities Renewal and Rehabilitation. The deteriorated condition of the physical plant stems from the design of LBL's oldest buildings and utilities and the changes in scientific needs since 1940. The characteristics of shops and support facilities, such as climate control, cleanliness, electrical and plumbing service do not meet current research standards. Related institutional facilities needs include replacement of electrical and mechanical utility systems and environmental, health and safety projects. LBL has prepared a "bare bones" program to prevent further deterioration of the physical plant that will cost $11 M per year (in FY 1987 dollars) over a 15 year period. Achievement of this restoration program and allocation of limited capital resources are continuing institutional issues for the Laboratory.

Question 10. The Energy Research Advisory Board (ERAB) recently issued its report "Geoscience Research for Energy Security." Please comment on each of the four principal recommendations of that report:

a. The DOE should modify its policy and give the highest geoscience research priority to shorter-term, lower-risk options for energy supplies upon which the nation will be primarily dependent for at least the next two decades.

DOE geoscience research priorities should support a balanced scientific program addressing both short- and long-term energy supply and energy waste product options, as well as a balanced effort in each of the major energy resources—petroleum, nuclear, coal and geothermal. A balanced strategy for DOE geoscience research can best be achieved through: (a) continued strong support for basic research on crustal structure and processes, (b) enhanced support for applied geoscientific and geological engineering research as well as advanced technology applications to geoscience problems, and (c) peer review and guidance on planning and policy by recognized geoscientists from all segments of the nation. The recent establishment of the Basic Energy Sciences Advisory Committee (BESAC) by the Department will be extremely helpful in determining the scientific and funding priorities of the geoscience program.

b. **Establish in the DOE an Office of Geoscience Research to develop and administer a strategic plan for geoscience research activities within the Department, especially in oil and gas and other liquid hydrocarbon conversion options.**

The Engineering and Geosciences program within the Office of Basic Energy Sciences has done an admirable job in planning and implementing basic geoscience research activities in the face of constrained budgets. Rather than expending a major effort to establish a separate Office of Geoscience Research, it might be more productive to increase funding for the existing program management and charge them with the tasks recommended by the ERAB report.

c. **Establish oil and gas research centers within each of the six major oil and gas provinces of the United States to conduct and coordinate interdisciplinary problem-oriented research in the following areas, all of which mitigate the problem of domestic hydrocarbon supply: enhanced oil recovery, unconventional natural gas recovery, subtle petroleum trap exploration, and geological basin analysis.**

The need for establishing new research centers dedicated to oil and gas resource problems is not clear. Implementation of the DOE geoscience research programs should continue to use the nation's best geoscientists whether in universities, national laboratories or the private sector. The infrastructure for enhanced DOE geoscience activities exists in these institutions—it only needs DOE management encouragement to better coordinate efforts, conduct comprehensive interdisciplinary research, collaborate in training young scientists and engineers, and to incorporate developing technologies.

d. **Increase oil and gas research funding by an initial annual increment of $50 million, primarily to support the regional research centers.**

The geoscience research programs within DOE are disproportionately constrained by budgets and management priorities. An enhanced national geoscience effort needs significantly increased funding. The exact amount of the increment should be balanced among the needs of other DOE energy and basic research programs.

Question 11. Please describe the Strategic Defense Initiative (SDI) efforts you have been and are conducting at your laboratory. What are the actual and estimated SDI funding levels for your laboratory you have received (both DOE and DOD) for each of FY 1986, FY 1987, and FY 1988?

The Laboratory has only minimal involvement in SDI funded research and this has been in program areas of traditional Laboratory strength. The development of a negative-ion based neutral beam source has been funded by DOD at $2.8 million in FY 1986, $2.0 million in FY 1987 and is projected to be $2.0 million in FY 1988. In addition, the Laboratory is submitting two proposals to the Department of Energy for research into (a) novel high-power, high-temperature electrochemical cells and (b) thermal-radiative electrical generators for space applications. Funding is being requested at $200,000 per project beginning in FY 1988.

Question 12. What pressing needs of your laboratory are not addressed adequately in the DOE's FY 1988 budget request? What funding would be necessary in FY 1988 to meet these needs and what will be the consequences if these additional funds are not made available?

The Laboratory's research facilities and equipment represent a national investment in buildings and equipment of nearly $600 M. Operating and improving these national facilities is essential for adequate conduct of LBL's research, educational and technology transfer mission. DOE's funding request does not adequately address operational and facilities renewal requirements: in particular operational support for the Laboratory's user facilities is inadequate to meet demands, and capital funds for facilities renewal and general purpose equipment are not adequate to reverse deterioration of the existing physical plant and/or to provide for modern technological laboratories to continue conducting advanced basic research activities.

Operational support for the Laboratory's major national user facilities— the Bevalac, the SuperHILAC, the 88-Inch Cyclotron and the National Center for Electron Microscopy—is inadequately addressed in DOE's FY 1988 budget request. The Bevalac serves the nation's scientific programs in nuclear physics and biomedicine. This research continues to address the forefront questions in nuclear physics. For example, during 1984 and 1985, Bevalac research contributed essential information towards defining the phases of nuclear matter, and during 1986 and 1987 is allowing for definition of unique nuclear radii and magnetic moments—information essential to understanding the properties of matter.

To operate the Bevalac, the Laboratory's funding request to the Department of Energy for FY 1988 was $23 million which would have provided 4000 hours of beam time for users. The Department's FY 1988 budget would continue operation at the FY 1987 level of 3200 hours. The Bevalac optimal operating level of 4000 hours was last achieved in 1984.

Funds for general purpose capital improvements are provided by two DOE budget categories: Multiprogram Energy Laboratories Facilities Support, and General Plant Projects. Renewal of the Laboratory's physical plant will require an investment of $101 million in Facilities Support funds, as indicated in the Laboratory's FY 1987-1992 Institutional Plan. As an initial step towards this goal, the Laboratory requested funds for seven projects amounting to $24.9M with an FY 1988 cost of $5.0M. The DOE FY 1988 budget includes a start on two projects costing $15.4M with an FY 1988 appropriation of $1.7M. Worthy utility rehabilitation and replacement projects were not funded.

The Laboratory receives $1.3 M in General Purpose Equipment funds annually to cover the cost of vehicles, engineering shop machinery, office equipment, computer and communications hardware and other general purpose needs. The current backlog of General Purpose Equipment costs is $10.6 M. Significant progress toward correcting this problem would be made if, for example, funding were doubled to $2.6 M, to eliminate the backlog over a four year period. The Laboratory requested a slightly larger figure, $3.0 M, for General Purpose Equipment in FY 1988.

The Laboratory also has a significant backlog of General Plant Projects that are of a smaller scale than the Facilities Support Projects. This backlog totals $33 M for 1988 through 1992. The Laboratory requested $5.5 M for General Plant Projects in FY 1988, and the Department's budget request included $2.4 M for these projects.

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